How Microwave Cooking Works

by Marshall Brain

The microwave oven is one of the great inventions of the 20th century - millions of homes in America have one. Microwave ovens are popular because they cook food incredibly quickly. They are also extremely efficient in their use of electricity because a microwave oven heats *only* the food - nothing else.

A microwave oven uses **microwaves** to heat food. Microwaves are radio waves. In the case of microwave ovens, the commonly used radio wave frequency is roughly 2,500 megahertz (2.5 gigahertz). Radio waves in this frequency range have an interesting property: they are absorbed by water, fats and sugars. When they are absorbed they are converted directly into atomic motion - heat. Microwaves in this frequency range have another interesting property: they are not absorbed by most plastics, glass or ceramics. Metal reflects microwaves, which is why metal pans do not work well in a microwave oven.

How Microwave Ovens Cook Food

You often hear that microwave ovens cook food "From the inside out." What does that mean? Here's an explanation to help make sense of microwave cooking.

Let's say you want to bake a cake in a conventional oven. Normally you would bake a cake at 350 degrees F or so, but let's say you accidentally set the oven at 600 degrees instead of 350. What is going to happen is that the outside of the cake will burn before the inside even gets warm. In a conventional oven, the heat has to migrate (by conduction) from the outside of the food toward the middle (See the HSW article entitled How a Thermos Works for a good explanation of conduction and other heat transfer processes). You also have dry, hot air on the outside of the food evaporating

moisture. So the outside can be crispy and brown (e.g. - bread forms a crust) while the inside is moist.

In microwave cooking, the radio waves penetrate the food and excite water and fat molecules pretty much evenly throughout the food. There is no "heat having to migrate toward the interior by conduction". There is heat everywhere all at once because the molecules are all excited together. There are limits of course. Radio waves penetrate unevenly in thick pieces of food (they don't make it all the way to the middle), and there are also "hot spots" caused by wave interference, but you get the idea. The whole heating process is different because you are "exciting atoms" rather than "conducting heat".

In a microwave oven, the air in the oven is at room temperture, so there is no way to form a crust. That is why foods like "Hot Pockets" come with a little cardboard/foil sleeve. You put the food in the sleeve and then microwave it. The sleeve reacts to microwave energy by becoming very hot. This exterior heat lets the crust become crispy as it would in a conventional oven.

Links

Microwave ovens are described by several interesting links on the web. Try these:

- For an excellent discussion of the different parts of a microwave oven and how they work together, click here.
- For a great collection of in-depth questions and answers about microwaves, click here.

© 1998 - 2004 HowStuffWorks, Inc.

HSW MEDIA NETWORK A CONVEX COMPANY

howstuffworks
it feels good to know.
Search
go
go back
close
The website below is governed by its own terms and conditions; its owner has no affiliation with HowStuffWorks.com.

How Does A Microwave Oven Work?

Basic Theory of Operation

Excerpts from the book ***The Complete Microwave Oven Service Handbook***
--NOW available on CD-ROM (CLICK HERE)
and from the video ***You Can Fix Your Microwave Oven, Plus VCR Know-How***
Copyright ©, 1989-2000 by J. Carlton Gallawa

Debussy's L'Îsle Joyeuse for your listening enjoyment.
(Use right mouse button on note icon to start and control music)

How A Microwave Oven Works

Microwave ovens use various combinations of electrical circuits and mechanical devices to produce and control an output of microwave energy for heating and cooking. Generally speaking the systems of a microwave oven can be divided into two fundamental sections, the ***control section*** and the ***high-voltage section*** .

The ***control section*** consists of a timer (electronic or electromechanical), a system to control or govern the power output, and various interlock and protection devices. The components in the high-voltage section serve to step up the house voltage to high voltage. The high voltage is then converted microwave energy.

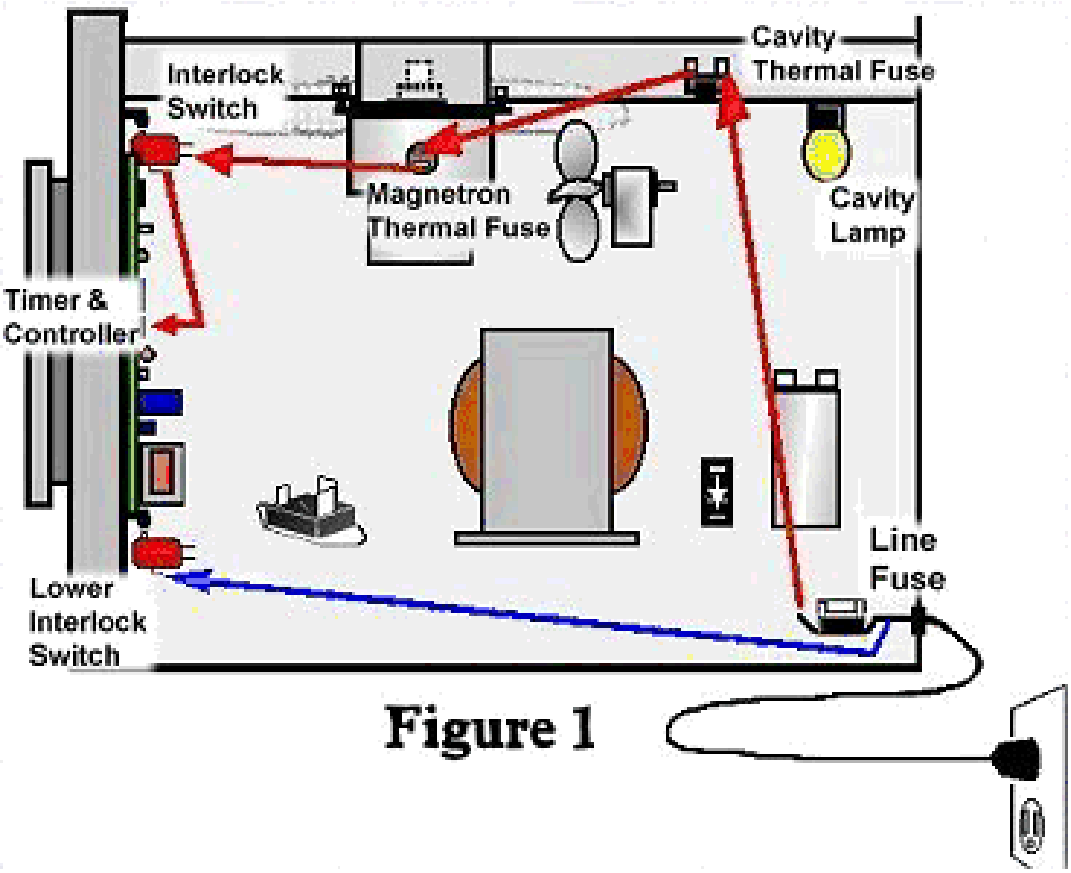


Figure 1

Basically, here is how it works: As shown in **Figure 1**, electricity from the wall outlet travels through the power cord and enters the microwave oven through a series of fuse and safety protection circuits. These circuits include various fuses and thermal protectors that are designed to deactivate the oven in the event of an electrical short or if an overheating condition occurs

If all systems are normal, the electricity passes through to the interlock and timer circuits. When then oven door is closed, an electrical path is also established through a series of safety interlock switches . Setting the oven timer and starting a cook operation extends this voltage path to the ***control circuits*** .

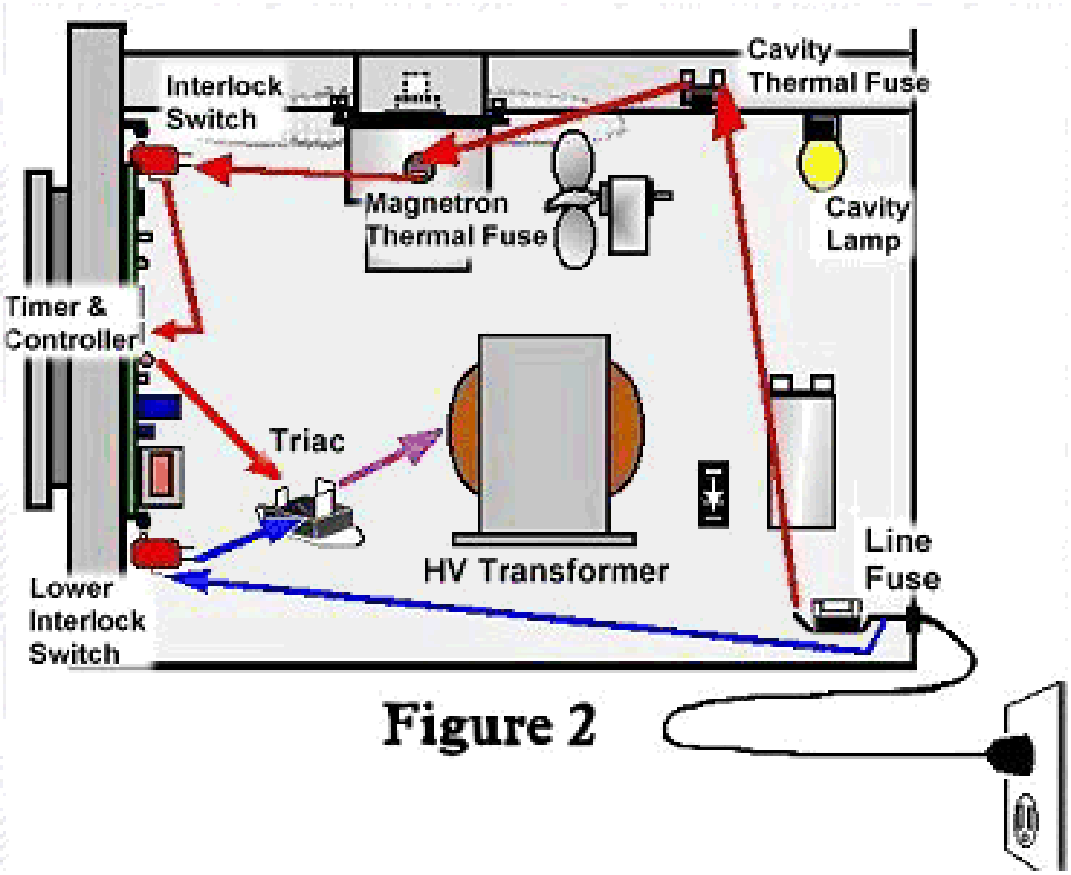


Figure 2

Generally, the control system includes either an electromechanical relay or an electronic switch called a triac as shown in **Figure 2** . Sensing that all systems are "go," the control circuit generates a signal that causes the relay or triac to activate, thereby producing a voltage path to the high-voltage transformer . By adjusting the on-off ratio of this activation signal, the control system can govern the application of voltage to the high-voltage transformer, thereby controlling the on-off ratio of the magnetron tube and therefore the output power of the microwave oven. Some models use a fast-acting power-control relay in the high-voltage circuit to control the output power.

In the ***high-voltage section*** (**Figure 3**), the high-voltage transformer along with a special diode and capacitor arrangement serve to increase the typical household voltage, of about 115 volts, to the shockingly high amount of approximately 3000 volts! While this powerful voltage would be quite unhealthy -- even deadly -- for humans, it is just what the magnetron tube needs to do its job -- that is, to dynamically convert the high voltage in to undulating waves of electromagnetic cooking energy.

The microwave energy is transmitted into a metal channel called a ***waveguide*** , which feeds the energy into the cooking area where it encounters the slowly revolving metal blades of the ***stirrer blade*** . Some models use a type of ***rotating antenna*** while others rotate the food through the waves of energy on a revolving carousel. In any case, the effect is to evenly disperse the microwave energy throughout all areas of the cooking compartment. Some waves go directly toward the food, others bounce off the metal walls and flooring; and, thanks to special metal screen, microwaves also reflect off the door. So, the microwave energy reaches all surfaces of the food from every direction.

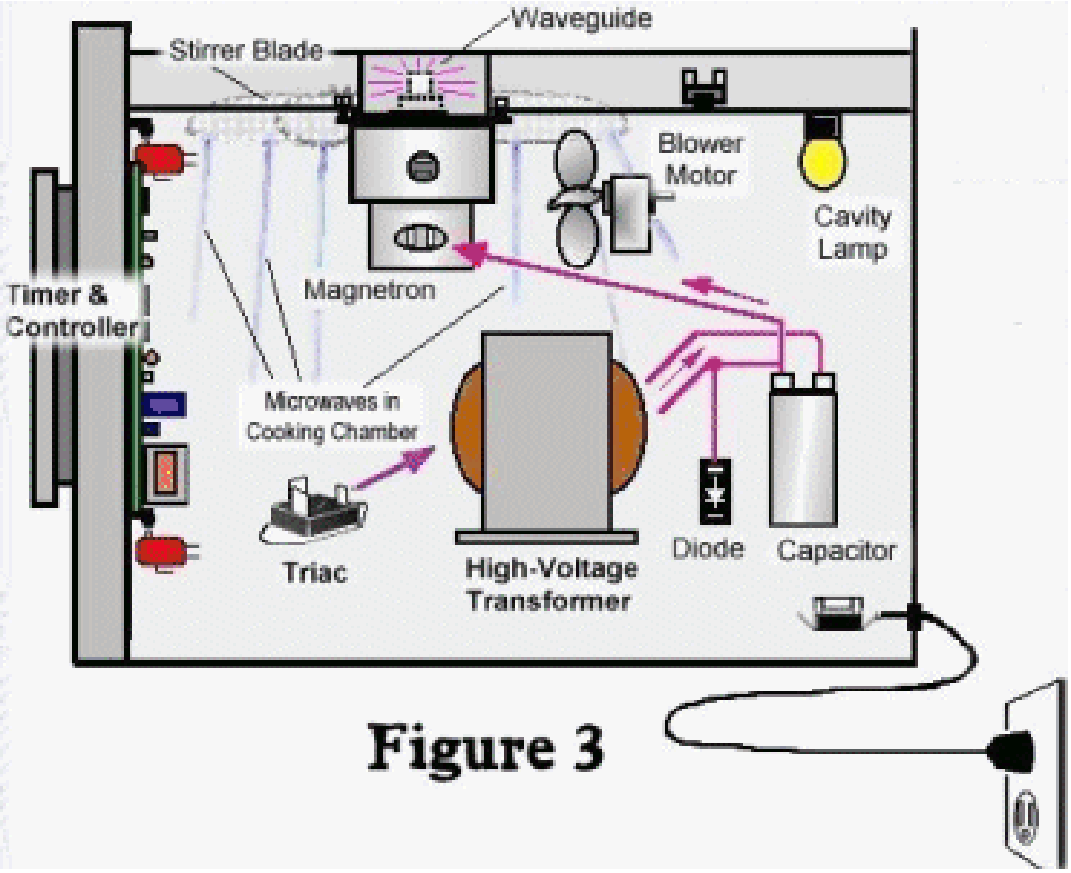


Figure 3

All microwave energy remains inside the cooking cavity. When the door is opened, or the timer reaches zero, the microwave energy stops--just as turning off a light switch stops the glow of the lamp

Learn more about the myths & mysteries of microwave ovens

| Back | Send Email | Home Page | Microwave OvenCD-ROM Repair Course | Free FiX Finder Repair Database | FAQ | Links |

Copyright Information

Unless otherwise noted, all materials at this cite (including without limitation all text, html markup, graphics, and graphic elements) are copyrighted ©, 1989-2000 by J. Carlton Gallawa. The material available through this site may be freely used for attributed ***noncommercial educational*** purposes only. We ask that due credit and notification be given the author.

All materials appearing on this website may not be reproduced, stored in any retrieval system, or used in any way for commercial purposes without the express prior written permission of the copyright holder.

Send correspondence to: **Microtech, P.O. Box 940, Gonzalez, Florida 32560**

Disclaimer: *The author assumes no liability for any incidental, consequential or other liability from the use of this information. All risks and damages, incidental or otherwise, arising from the use or misuse of the information contained herein are entirely the responsibility of the user. Although careful precaution has been taken in the preparation of this material, we assume no responsibility for omissions or errors.*

Debussy's ***L'Îsle Joyeuse*** courtesy of David Siu and The Classical Midi Connection: http://www.dtx.net/~raborn/

As of 12/25/97 you are visitor number 212985

How Do Microwaves Cook?

Excerpts from the book ***The Complete Microwave Oven Service Handbook***
--NOW available on CD-ROM (CLICK HERE)
and from the video ***You Can Fix Your Microwave Oven, Plus VCR Know-How***
Copyright ©, 1996-99 by J. Carlton Gallawa

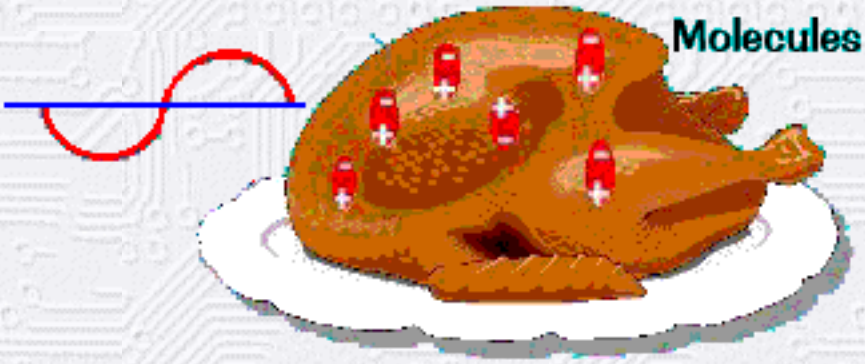
Music of Claude Debussy for your listening enjoyment.
(Use right mouse button on note icon to start and control music)

Microwaves possess three basic characteristics:

1. Just as sunlight shines through a window, microwaves pass right through some materials. Materials such as glass, paper, and plastic are transparent to and generally unaffected by microwaves.
2. Microwaves are reflected by metal surfaces, much as a ball would bounce off a wall. The metal walls of the cooking space actually form a *cavity resonator*. In other words, the enclosure is designed to *resonate* the microwaves as they are radiated from the magnetron tube. The principle of resonance may be illustrated using sound waves. When a piano key is struck, it produces sound vibrations or sound waves. Sometimes a note is played on a piano, and an object across the room, perhaps a wineglass, can be heard vibrating and producing the same sound. This is the result of resonance. The resonating characteristics of the wineglass are the same as those of the piano string. Therefore, the wineglass is in tune, or in resonance, with the sound wave produced by the piano string. In the same way, the cooking cavity of a microwave oven is designed to be in "tune" with the resonant characteristics of the microwaves.
    - Metal racks are physically proportioned so as not to disrupt the energy pattern.
3. Microwaves penetrate and are absorbed by some substances, primarily food products.

Friction Produces the Heat That Cooks the Food

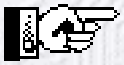
To illustrate this third characteristic, notice the cooked turkey to the right. The waves of microwave energy are cycling above and below a horizontal baseline. The half cycle below the baseline possesses negative properties, and the half cycle above the line is correspondingly positive. Basically, the effect of this wave, as it alternates between positive and negative, would be like a magnet flipping back and forth.



All liquids and food products, such as this turkey, are made up of molecules. These molecules have positive and negative particles, so they tend to behave like microscopic magnets. As the positive half cycle of the microwave penetrates the food, the negative particles of the molecules are attracted and attempt to align themselves with this positive field of energy. Then, when the microwave energy alternates to the negative half cycle, the opposite occurs -- The negative particles are repelled and the positive particles are attracted, causing a flipping motion (actually, this reaction is the movement of the particles within each molecule, so, technically, they reverse polarity). This might be compared to a room full of people trying to run back and forth, from one side to the other. Obviously, there would be a lot of bumping, rubbing, agitation, and *friction*.

Now, consider that the actual frequency of the RF energy used in microwave ovens is 2450 million cycles per second! Moreover, consider that within the course of one of those cycles, the molecules would actually change their direction (polarity) twice - once for the positive half-cycle and once for the negative half-cycle. This red-hot rate of vibration causes tremendous friction within the food, and - just as rubbing your hands together makes them warm - this friction produces heat.

So the heat is produced directly in the food, but the food is not cooked, as is commonly believed, from the inside out. Actually, the cooking begins just beneath the outer surface and from there inward and outward, with the majority of the energy being expended in the outer layers. The rate and degree of heating depend on the depth and density of the food, as well as its ability to conduct heat. Because the microwave energy is changed to heat as soon as it is absorbed by the food, it cannot make the food radioactive or contaminated. When the microwave energy is turned off and the food is removed from the oven, there is no residual radiation remaining in the food. In this regard, a microwave oven is much like and electric light that stops glowing when it is turned off.

Learn more about the myths & mysteries of microwave ovens 

| Back | Send Email | Top of Page | Home Page | Microwave Oven Video Repair Course | Free FiX Finder Repair Database | FAQ | Links |

Copyright Information

Unless otherwise noted, all materials at this cite (including without limitation all text, html markup, graphics, and graphic elements) are copyrighted ©, 1989-99 by J. Carlton Gallawa. The material available through this site may be freely used for attributed ***noncommercial educational*** purposes only. We ask that due credit and notification be given the author.

All materials appearing on this website may not be reproduced, stored in any retrieval system, or used in any way for commercial purposes without the express prior written permission of the copyright holder.

Send correspondence to: **Microtech, P.O. Box 940, Gonzalez, Florida 32560**

Disclaimer: *The author assumes no liability for any incidental, consequential or other liability from the use of this information. All risks and damages, incidental or otherwise, arising from the use or misuse of the information contained herein are entirely the responsibility of the user. Although careful precaution has been taken in the preparation of this material, we assume no responsibility for omissions or errors.*

You are visitor number 46001 since 12/25/97

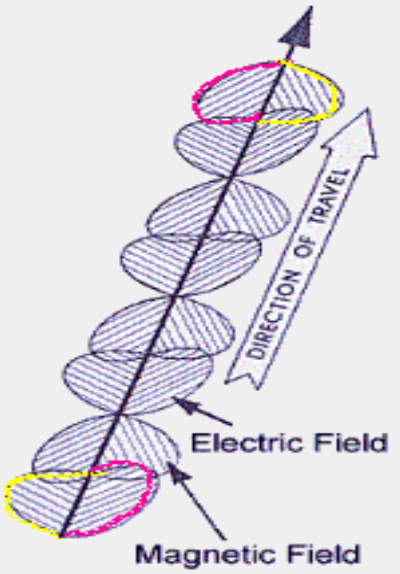
Attention Repair Technicians:
Want to boost profits by learning to repair commercial microwave ovens?
OK

What Are Microwaves?

Excerpts from the book ***The Complete Microwave Oven Service Handbook***
--NOW available on CD-ROM (***CLICK HERE***)
Copyright ©, 1989-2000 by J. Carlton Gallawa
and from the video ***You Can Fix Your Microwave Oven, Plus VCR Know-How***

Debussy's L'Îsle Joyeuse for your listening enjoyment.
(Use right mouse button on note icon to start and control music)

Microwaves are very short waves of electromagnetic energy that travel at the speed of light (186,282 miles per second). Microwaves used in microwave ovens are in the same family of frequencies as the signals used in radio and television broadcasting.



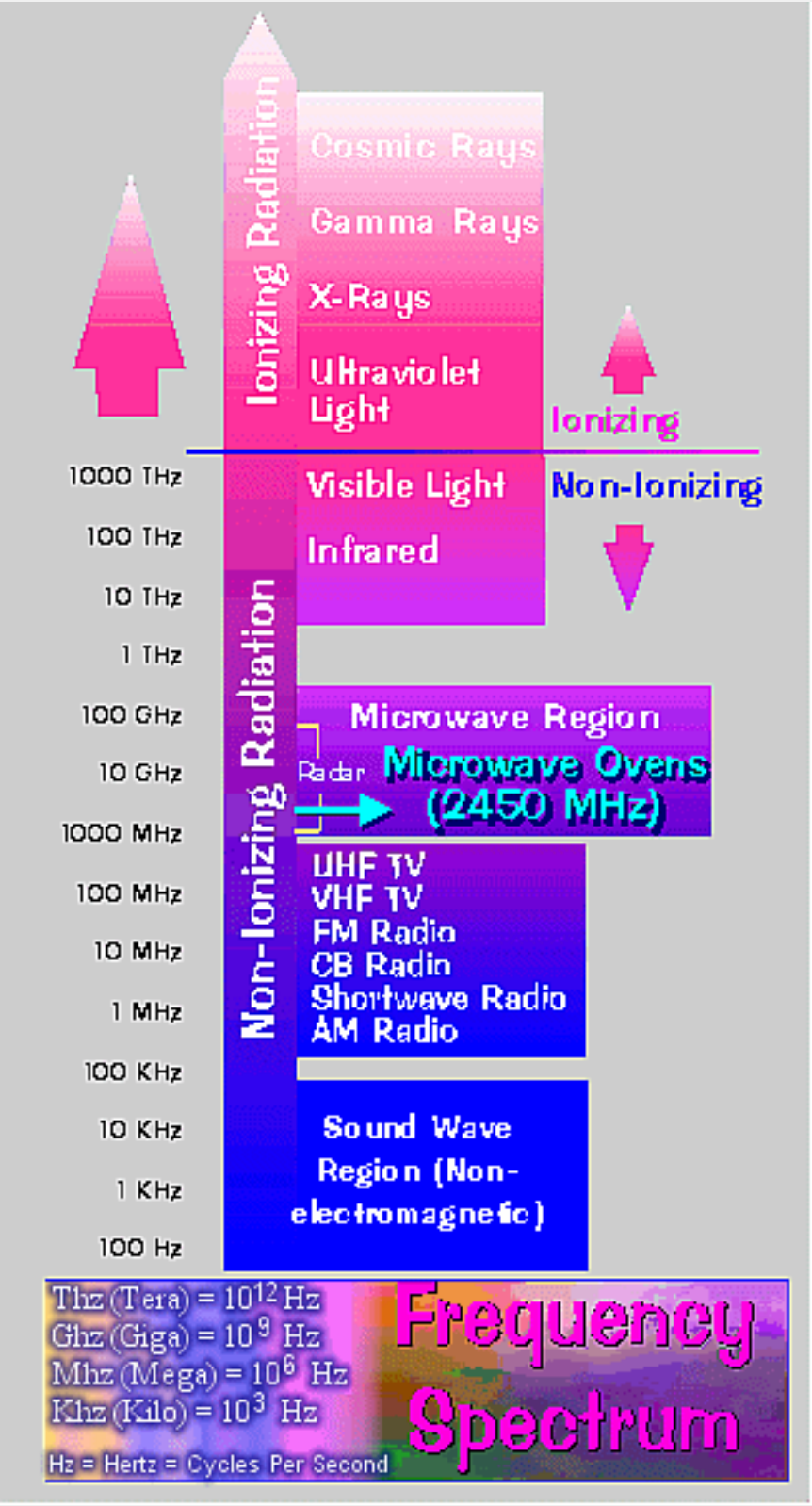
Microwave Energy Traveling Through Space
(Courtesy Michael S. Wagner)

The theory of electromagnetic energy can be illustrated by what happens when a pebble is tossed into a quiet pond. The pebble striking the still surface causes the water to move up and down in the form of ripples, or waves, that radiate in ever-widening circles over the surface of the pond. These waves, which move up and down at right angles to the direction they are traveling, are called transverse waves. Microwaves are examples of transverse waves.

The disturbance resulting from the pebble landing in the water is transmitted through the water in the form of ripples or waves. The water serves merely as a medium through which the disturbance travels. In this sense, these ripples are more like sound waves, which also need a medium to travel through, normally using the molecules that exist in the air or water. That is why, for example, thundering rocket engines that would deafen the ears under normal circumstances, would be inaudible in the quiet vacuum of space.

On the other hand, electromagnetic forms of energy, such as microwaves, radar waves, radio and TV waves, travel millions of miles through the emptiness of space without the need of any material medium through which to travel. This is because, simply put, electromagnetic waves are, in themselves, stored energy in motion.

A Phenomenal Force



Electromagnetic radiation begins with a phenomenon that occurs when electric current flows through a conductor, such as a copper wire. The motion of the electrons through the wire produces a field of energy that surrounds the wire and floats just off its surface. This floating zone or cloud of energy is actually made up of two different fields of energy, one electric and one magnetic. The electric and magnetic waves that combine to form an electromagnetic wave travel at right angles to each other and to the direction of motion. If the current flowing through the wire is made to oscillate at a very rapid rate, the floating electromagnetic field will break free and be launched into space. Then, at the speed of light, the energy will radiate outward in a pulsating pattern, much like the waves in the pond. It is theorized that these waves are made up of tiny packets of radiant energy called photons. Streams of photons, each carrying energy and momentum, travel in waves like an undulating string of cars on a speeding roller coaster.

Is Microwave Radiation the Same as Radioactive Radiation?

No. There is a very important difference. As illustrated by the frequency spectrum on the right, microwaves used in microwave ovens, similar to microwaves used in radar equipment, and telephone, television and radio communication, are in the *non-ionizing* range of electromagnetic radiation. Non-ionizing radiation is very different from *Ionizing radiation* . Ionizing radiation is extraordinarily high in frequency (millions of trillions of cycles per second). It is, therefore, extremely powerful and penetrating. Even at low levels, ionizing radiation can damage the cells of living tissue. In fact, these dangerous rays, have enough energy and intensity to actually change (ionize) the molecular structure of matter. In sufficient doses, ionizing radiation can even cause genetic mutations. As shown on the frequency spectrum, the ionizing range of frequencies includes X-rays, gamma rays, and cosmic rays. Ionizing radiation is the sort of radiation we associate with radioactive substances like uranium, radium, and the fall-out from atomic and thermonuclear explosions.

Non-ionizing radiation is very different. Because of the lower frequencies and reduced energy, it does not have the same damaging and cumulative properties as ionizing radiation. Microwave radiation (at 2450 MHz) is non-

ionizing, and in sufficient intensity will simply cause the molecules in matter to vibrate, thereby causing friction, which produces the heat that cooks the food.

Copyright Information

Unless otherwise noted, all materials at this cite (including without limitation all text, html markup, graphics, and graphic elements) are copyrighted ©, 1989-2000 by J. Carlton Gallawa. The material available through this site may be freely used for attributed ***noncommercial educational*** purposes only. We ask that due credit and notification be given the author.

All materials appearing on this website may not be reproduced, stored in any retrieval system, or used in any way for commercial purposes without the express prior written permission of the copyright holder.

Send correspondence to: **Microtech, P.O. Box 940, Gonzalez, Florida 32560**

Disclaimer: *The author assumes no liability for any incidental, consequential or other liability from the use of this information. All risks and damages, incidental or otherwise, arising from the use or misuse of the information contained herein are entirely the responsibility of the user. Although careful precaution has been taken in the preparation of this material, we assume no responsibility for omissions or errors.*

Back | Send Email | Top of Page | Home Page | **FREE** samples from *THE COMPLETE MICROWAVE OVEN SERVICE HANDBOOK*

Debussy's ***L'Îsle Joyeuse*** courtesy of David Siu and The Classical Midi Connection: http://www.dtx.net/~raborn/

You are visitor number 65322

The Purpose and Function of Interlock Switches Used In Microwave Ovens

© 1996-2002 J. Carlton Gallawa . All Rights Reserved Worldwide

To ensure safe operation, all microwave ovens are equipped with safety ***interlock switches*** . The door-interlock system is one of the most significant safeguards in a microwave oven. While switch configuration, size, shape, and mounting arrangement may vary from one model to the next, the purpose and basic operation remain the same in all models.

Typical Interlock Switch

The purpose of the interlock system is to interrupt the production of microwave energy when the oven door is opened, and similarly, to prevent any microwave output until the door is firmly and safely closed.

A principal component of the interlock system is the ***interlock monitor switch*** . In August of 1974, a Federal safety standard went into effect that required that all microwave ovens be equipped with an interlock monitoring system. The monitor switch, which is also called the *safety switch, short switch, sensing switch,* and *failure detector switch* , functions as a fail-safe type of device, in that it disables the microwave oven if an interlock failure should occur. The actual method differs from model to model, but the results are the same:a blown (or opened) fuse.

Generally speaking, the normal sequence of switch operation when the door is opened is as follows. First the primary switch opens its contacts. Second, (yes) the secondary switch opens. Finally, the interlock monitor switch *closes* its contacts. The fail-safe system works like this:If any of the switches and/or relays included in the monitor loop (or circuit) fail to open their contacts properly when the door is opened, a short circuit is created when the monitor switch closes its contacts. The closed contacts of the monitor switch and the faultily-closed contacts of the defective switch combine to cause an immediate short circuit, which, in one way or another (depending on the model), blows the line fuse, or otherwise disables the oven. All this happens before the door can be opened far enough to allow any dangerous levels of microwave radiation to escape.

All switches have a voltage and current rating. A typical door-interlock switch is rated at 15 amps with 125 or 250 VAC applied. When replacing an interlock switch, these ratings must be met or exceeded, otherwise premature switch failure will result. Another replacement consideration is the *operating* and *release* force. This is the relative amount of pressure needed to actuate the switch. Various applications call for differing amounts of operating pressure. Like the voltage and current ratings, this is an important factor when obtaining a replacement switch. For example, if the normal pressure of a latch mechanism is insufficient to depress the actuator button, the switch's operating force is probably too high for that application.

The interlock switch to be tested in this example has a COM. (common) terminal, a N.O. (normally open) terminal, and a N.C. (normally closed) terminal. Interlock monitor switches are usually constructed with only the COM and N.C. terminals. Other switches are made with just the COM and N.O. terminals. The following tests will cover most circumstances. Simply disregard the terminal-to-terminal tests that do not apply.

Important Safety Information

Working on a microwave oven is a very dangerous task. Therefore, BEFORE performing any tests, troubleshooting or repairs, for your personal safety, we strongly urge you to carfully read, fully understand and be prepared to follow the very important safety precautions found by clicking here .

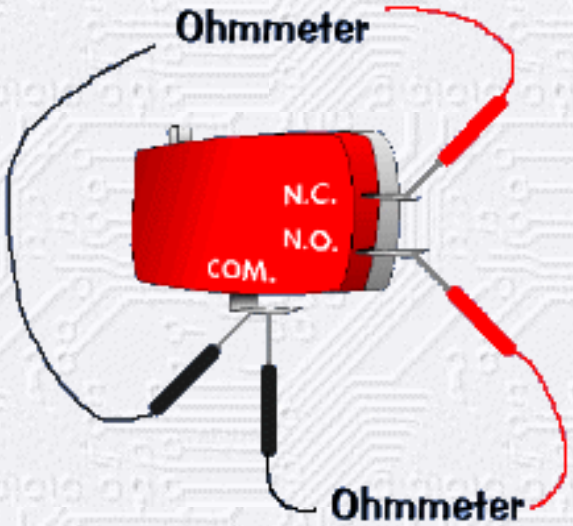
Please read the disclaimer at the bottom of this page.

How To Test Interlock Switches

1. **Unplug the oven** and remove the outer cover.
2. **DISCHARGE ALL HIGH VOLTAGE CAPACITORS. (Procedure)**
3. Visually examine the switch terminals and connectors for signs of overheating, such as discoloration, or brittleness.
    - Many times the problem is merely a burned slip-on connector due to a poor crimp joint, or weakened connection. If the switch is in good working order, the repair can be made by cleaning the terminals, and replacing the burned connector. Or, simply cut off the burned connectors and solder the wires directly to the switch terminals.
4. Carefully remove the harness leads from the switch terminals. Pry them loose if necessary, but do not exert too much force, or the terminal may break right out of the switch.
    - Many models use a connector with a locking clip in the center of the receptacle

terminal. This extruding lever must be pressed down while gently pulling the connector off the terminal.

5. Set the ohmmeter to read ohms at a scale of R X 1
6. As shown in the picture, place one meter probe on the COM terminal and the other probe on the N.O. terminal. With the actuator (or lever, or button) not depressed, the meter should read infinity (an open circuit).
7. Without moving the meter probes, press down on the switch actuator until a "click" is heard. At the point of the click, the meter should swing to a reading of zero ohms (or continuity).
    - Rule of thumb:A healthy "click" usually means the switch is working normally. However, switches with just two terminals, both of which come out the back, do not click when actuated, and neither do switch modules.



8. Move the probe from the N.O. terminal to the N.C. terminal. The other probe remains on the COM terminal.
9. Press the actuator and the meter should read infinity.
10. Release the actuator and the meter should read zero ohms.
11. Set the meter to the highest resistance (ohms) scale and measure from the N.C. terminal to the N.O. terminals for a normal reading of infinity.
12. Measure from each terminal to any metal mounting hardware that is part of the switch assembly for a normal reading of infinity.

Any abnormal readings would indicate that the switch is defective and should be replaced.

Send us E-mail. Let us know what you think: **microtech@gallawa.com**

Attention Appliance Repair Technicians:
Want to Expand your Services and Build Bigger Profits?

A Complete Course In Commercial & Residential Microwave Oven Repair

Step up to a new level of instruction!

Copyright © Information

Unless otherwise noted, all materials at this cite (including without limitation all text, html markup, graphics, and graphic elements) are copyrighted © 1989-2002 by J. Carlton Gallawa. The material available through this site may be freely used for attributed *noncommercial educational* purposes only. We ask that due credit and notification be given the author.

All materials appearing on this website may not be reproduced, stored in any retrieval system, or used in any way for commercial purposes without the express prior written permission of the copyright holder.

Send correspondence to: Microtech, P.O. Box 940, Gonzalez, Florida 32560

Disclaimer: ***The author assumes no liability for any incidental, consequential or other liability from the use of this information. All risks and damages, incidental or otherwise, arising from the use or misuse of the information contained herein are entirely the responsibility of the user. Although careful precaution has been taken in the preparation of this material, we assume no responsibility for omissions or errors.***

BACK | SELECT BRAND | HELP via EMAIL | SAFETY INFORMATION | HOME | CD-ROM

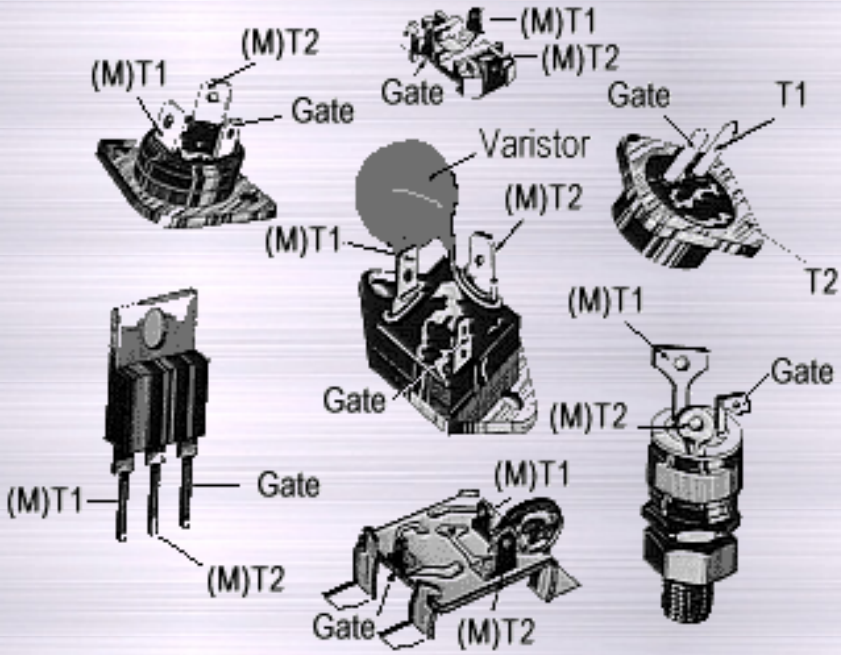
The Purpose of the Triac

© 1996-2002 J. Carlton Gallawa . All Rights Reserved Worldwide

The triac is an electronic relay or switch. Triacs come in many shapes, sizes and colors. The black and white illustration to the right shows most of the types of triacs that are commonly used in microwave ovens, along with their standard terminal designations.

Located either externally or fixed within the controller, the triac operates when it receives an electronic "gate" signal from the control circuitry. It then switches to its closed or "on" state, thus providing a voltage path to the primary winding of the high voltage transformer, thereby energizing the cook circuits.

Considering the heavy job that the triac does, it's not surprising that it is a common candidate for failure.



Common Microwave Oven Triacs
Note: Actual relative sizes are not to scale
(Artwork courtesy of Michael S. Wagner)

Important Safety Information

Working on a microwave oven is a very dangerous task. Therefore, BEFORE performing any tests, troubleshooting or repairs, for your personal safety, we strongly urge you to carfully read, fully understand and be prepared to follow the very important safety precautions found by clicking here .

Please read the disclaimer at the bottom of this page.

How To Test the Triac

Triacs with three terminals, such as most of those shown above, can be tested by making a series of resistance checks as follows.

Test One

1. **Unplug the oven.**
2. **DISCHARGE THE HIGH VOLTAGE CAPACITOR. (Procedure)**
3. **First identify the terminals. The three terminals are generally designated as *G (gate)*, *T1* and *T2*. (A rule of thumb:smallest terminal is the gate; medium sized is T1; largest is T2.)**
4. **Carefully remove all harness leads. A soldered-in varistor or snubber may remain attached providing it's in good condition.**
5. **Set and zero the ohmmeter to a scale capable or reading about 40 ohms.**
6. **Measure from the *gate* to *T1* , note the reading, then reverse the leads.**
7. **In each measurement, a normal reading would be in the range of 10 to 200 ohms , depending on the model.**
8. **Next, set the meter to its highest resistance scale. Each of the following readings should produce a normal reading of *infinity:***
    a. **From *T1* to *T2*.**
    b. **From *T2* to the *gate***
    c. **From each terminal to chassis ground**

Note:These readings are approximate and may vary with manufacturer, but generally speaking, any results that are significantly different would point to a defective triac.

Test Two

A second way to test the triac is to evaluate its gate-firing capability:

1. **Unplug the oven.**
2. **DISCHARGE THE HIGH VOLTAGE CAPACITOR. (Procedure)**
3. Remove all harness leads. Set the meter to a scale capable of reading about 50 ohms.
4. Attach the ***negative*** meter lead to ***T1*** and the ***positive*** lead to ***T2*** .
5. Now, using a screwdriver blade, create a momentary short between ***T2*** and the ***gate*** . This brief contact should turn the triac "on," thus producing a meter reading of about 15 to 50 ohms.
6. Next, disconnect one of the meter leads, then re-connect it. The meter should return to a reading of ***infinity*** .
7. Finally, reverse the meter leads and repeat the tests. The results should be the same.

- Any abnormal tests would suggest a defective triac.
- Replacement triacs are generally available at electronic and appliance parts distributors.

Send us E-mail: **microtech@gallawa.com**

CLICK HERE

- **If you would like to learn more about repairing commercial, industrial and residential microwave ovens and become part of a multi-million dollar service industry, we invite you to take a look at Microtech's highly acclaimed CD-ROM.**
- **Take the finest repair video ever produced, combine it with the ultimate textbook on microwave oven repair, meticulously update every part and you have *"THE COMPLETE MICROWAVE OVEN SERVICE HANDBOOK v. 2002 on CD-ROM."* This is THE definitive step-by-step instructional CD to making safe, successful and profitable repairs on all types of microwave ovens.**
- **From the common tools you'll need and clearly outlined safety procedures, right down to the final profit-producing repair. This state-of-the-art courseware gives you the training you need in a progressive, straight-foward and easy-to-use format that's guaranteed to take you to the skill--and income--level you want.**
- **It takes every page of this 400-page, fact-crammed course to teach you all you need to know about this profitable field of repair.**

Disclaimer: *The author assumes no liability for any incidental, consequential or other liability from the use of this information. All risks and damages, incidental or otherwise, arising from the use or misuse of the information contained herein are entirely the responsibility of the user. Although careful precaution has been taken in the preparation of this material, we assume no responsibility for omissions or errors.*

Copyright © Information

Unless otherwise noted, all materials at this cite (including without limitation all text, html markup, graphics, and graphic elements) are copyrighted © 1989-2002 by J. Carlton Gallawa. The material available through this site may be freely used for attributed ***noncommercial educational*** purposes only. We ask that due credit and notification be given the author.

All materials appearing on this website may not be reproduced, stored in any retrieval system, or used in any way for commercial purposes without the express prior written permission of the copyright holder.

Send correspondence to: **Microtech, P.O. Box 940, Gonzalez, Florida 32560**

BACK SELECT BRAND HELP via EMAIL SAFETY INFORMATION HOME CD-ROM

The Purpose of the High Voltage Transformer in Microwave Ovens

Excerpts from the book ***The Complete Microwave Oven Service Handbook*** ***--NOW available on CD-ROM*** ***(CLICK HERE)*** and from the video ***You Can Fix Your Microwave Oven, Plus VCR Know-How*** - Copyright ©, 1989-2000 by J. Carlton Gallawa

© 1996-2002 by J. Carlton Gallawa . All Rights Reserved Worldwide

It might be said that the HIGH-VOLTAGE TRANSFORMER is the "muscle" of the microwave oven. With an input of 120 VAC (or 240 VAC in many commercial models) applied to the primary winding, the high-voltage transformer (also referred to as *power* or *plate* transformer) steps up that primary voltage to a very high voltage. This high voltage is then boosted even higher by the voltage-doubling action of the capacitor and diode. The resulting voltage, about 3000 - 5000 volts DC (depending on the model), is available at the *high voltage (output) tap* (see illustration below).

In most newer models, the transformer also incorporates a second output winding, as shown in the illustration below. This is a *stepped-down* output that provides the filament voltage (typically 3 to 4 VAC) to the magnetron tube.

Some models use a ***separate filament transformer*** . If that is the case, skip steps 3 through 5.

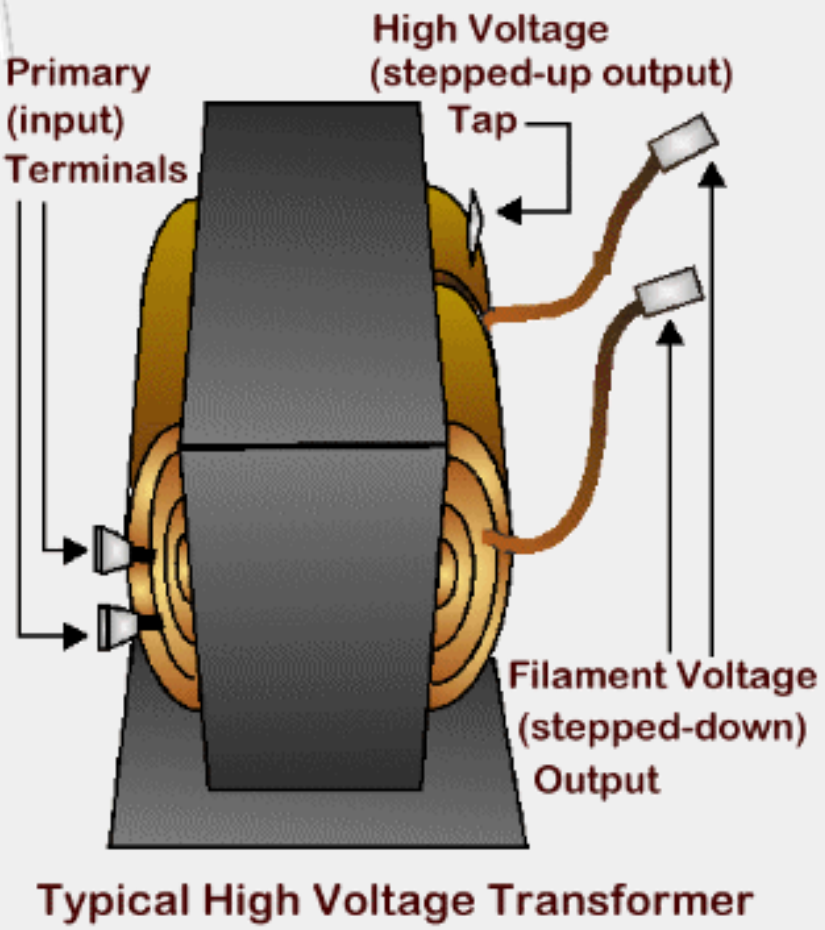
Important Safety Information

Microwave ovens are one of the most dangerous appliances to work on. Before attempting any troubleshooting, testing or repairs, for your personal safety we strongly urge you to carefully read, fully understand and be prepared to follow carefully the very important safety precautions found by clicking here .

Please read our disclaimer at the bottom of this page.

WARNING! THESE VOLTAGES CAN BE LETHAL! NEVER, EVER ATTEMPT TO MEASURE THE OUTPUT VOLTAGES OF THE HIGH-VOLTAGE TRANSFORMER.!

How To Test The High-Voltage Transformer

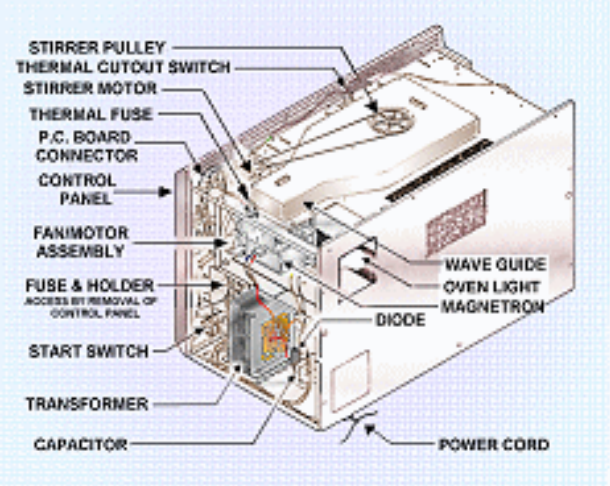


Typical High Voltage Transformer

1. **UNPLUG** the oven.
2. **DISCHARGE ALL HIGH-VOLTAGE CAPACITORS. (Procedure)**
3. Disconnect the high-voltage lead from the transformer's high-voltage terminal (or tap).
4. With an ohmmeter set to the lowest resistance scale, R X 1, measure the resistance from the high-voltage terminal to the transformer chassis (ground).
    a. Some early models are equipped with two or three high-voltage taps. If this is the case, perform the measurement from each tap to chassis ground.
5. The meter should read about 55 to 70 ohms, depending on which high-voltage tap is being measured and the model being tested.
    a. A substantially higher or lower reading would indicate that the transformer is defective.
6. Carefully disconnect the leads from the primary (input) terminals
7. Measure from one transformer primary terminal to the other for a normal reading of less than 1 ohm (i.e., .22 ohms)
    a. A substantially higher reading would indicate that the primary winding is open.
8. Set the meter to its highest resistance scale and check from each transformer primary terminal to the transformer chassis (ground) for a normal reading of infinity (open circuit).
    a. Any measurement of resistance would indicate some degree of a short to ground
9. Set the meter back to its lowest resistance scale. Then carefully disconnect the filament leads and measure from one filament terminal to the other for a normal resistance of less than 1 ohm.
10. Set the meter to its highest scale and measure from each filament terminal to chassis ground.
    a. Any measurement that is substantially different from the normal readings would indicate a defective transformer.

Send us E-mail if you have difficulty in locating this or any other replacement part. We will be happy to help you: **microtech@gallawa.com**

Illustration from THE COMPLETE MICROWAVE OVEN SERVICE HANDOOK



If you would like to learn more about repairing commercial and residential microwave ovens and become part of a multi-million dollar service industry, we invite you to take a look at Microtech's powerful new computerized training course.

- **Virtually 1000s of microwave oven repair case histories with factory approved troubleshooting and repair procedures**
- **Factory troubleshooting charts, error codes, schematics and diagnostic procedures**
- **Touch panel (key pad) matrix diagrams for 100s of brands**
- **Hundreds of vividly colored schematics, diagrams, illustrations and photos ease the toughest repair chores.**
- **Fully searchable text for quick information gathering**
- **All chapters, sections and references are hyperlinked for fast and smooth navigating**
- **FREE technical support**
- **Full 30-day, no-questions- asked, money-back guarantee**

THE COMPLETE MICROWAVE OVEN SERVICE HANDBOOK 2002
Operation, Maintenance, Troubleshooting and Repair
J. Carlton Gallawa

CLICK Free! SAMPLES

BACK | SELECT BRAND | HELP via EMAIL | SAFETY INFORMATION | HOME | CD-ROM

Copyright © Information

Unless otherwise noted, all materials at this cite (including without limitation all text, html markup, graphics, and graphic elements) are copyrighted © 1989-2002 by J. Carlton Gallawa. The material available through this site may be freely used for attributed ***noncommercial educational*** purposes only. We ask that due credit and notification be given the author.

All materials appearing on this website may not be reproduced, stored in any retrieval system, or used in any way for commercial purposes without the express prior written permission of the copyright holder.

Send correspondence to: **Microtech, P.O. Box 940 Gonzalez, FL 32560**

Disclaimer: *The author assumes no liability for any incidental, consequential or other liability from the use of this information. All risks and damages, incidental or otherwise, arising from the use or misuse of the information contained herein are entirely the responsibility of the user. Although careful precaution has been taken in the preparation of this material, we assume no responsibility for omissions or errors.*

ATTENTION TECHNICIANS!
Commercial microwave repair brings big profits! Learn how...
Amana
Hobart
Panasonic
Submit
Cancel

Website Directory:

Microtech Home Page

Microwave Oven FiX Finder Case History Database

CD-ROM Home Page

CD-ROM Samples

Search Our Website

Ordering Information

Send email

Microwave Oven FAQ

Related Links

About the author, J. Carlton Gallawa

Copyright © Information

Microwave Oven Parts Suppliers/ Manufacturer Contacts

© 1996-2004 J. Carlton Gallawa. All Rights Reserved Worldwide

Microwave Ovens Are Dangerous Appliances to Work On

The microwave oven is one of the most dangerous appliances to repair. The high-voltage potential combined with the high-current capability of an operating microwave oven pose a deadly threat to the reckless worker. In addition, microwave ovens are radiation-emitting devices. Normally this does not present a problem. However, improper replacement methods or tampering with safety systems could expose the unwary troubleshooter to dangerous levels of microwave leakage. **Therefore, extreme caution and proper procedures MUST be used at all times.**

When diagnosing a microwave oven, many problems can be detected merely with careful observation, that is, ***with the power disconnected***. Most tests can be accomplished with the power off and the oven unplugged. We suggest that you leave the "live" testing to the professionals. Nonetheless, certain safety habits must be developed and maintained. If you have experience in troubleshooting electrical equipment, some of these safety precautions may be familiar. However, the ***high-current potential*** of the high-voltage circuits in a microwave oven make them possibly life-saving steps.

If you are uneasy or unsure about any of these safety procedures or warnings; or if you feel uncertain as to their importance or your ability to manage them, it would be in your best interest to leave the repair to a qualified professional.

SUBMIT your REPAIR TIP

Glossary of Electronic and Microwave Oven Related Terms

Microtech Home Page

Microwave Oven FiX Finder Case History Database

CD-ROM Home Page

CD-ROM Samples

Search Our Website

Ordering Information

Send email

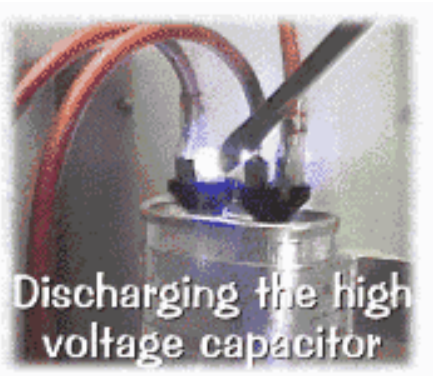
Microwave Oven FAQ

Related Links

About the author, J. Carlton Gallawa

Copyright © Information

- **FIRST** and **ALWAYS**, before attempting any repairs, make certain that the unit is not plugged in.
- Before touching any components or wiring, **ALWAYS** **DISCHARGE THE HIGH VOLTAGE CAPACITOR!** The high voltage capacitor will quite normally maintain a painfully high-voltagecharge even after the oven is unplugged. Some capacitors employ a bleeder resistor (either externally or internally) that allows the charge to slowly bleed (or drain) off after the oven is unplugged. Do not trust a bleeder resistor--it may be open.



If you forget to discharge the capacitor, your fingers may ultimately provide the discharge path. You only make this mistake a few times, because, while the electric shock is painful, the real punishment comes when you reflexively yank your hand out leaving behind layers of skin on razor-like edges that are there as a reminder to never again forget to discharge the high voltage capacitor.

How To Discharge The High Voltage Capacitor:The capacitor is discharged by creating a short circuit (direct connection) between the two capacitor terminals and from each terminal to chassis ground (bare metal surface).

1. Do this by touching the blade of an insulated-handled screw driver to one terminal, then slide it toward the other terminal until it makes contact and hold it there for a few seconds. (This can result in a rather startling "pop!")
2. Repeat the procedure to create a short between each capacitor terminal and chassis ground.
3. If the capacitor has three terminals, use the same procedure to create a short circuit between each terminal and then from each terminal to ground.
4. Older Amana-made models (generally those manufactured before 1977) have red, round filter capacitors mounted in the base of the magnetron tube which can also hold a charge. Ground each magnetron terminal by creating a short circuit to chassis ground using the blade of a screwdriver as explained above.

NEVER, under any circumstances, touch any oven components or wiring with your hand or even with an insulated tool during a cook operation.

The high-voltage circuits in a microwave oven generate from 3000 to 5000 volts DC and higher!

This combined with the potential for high current makes the **HIGH VOLTAGE CIRCUITS OF A MICROWAVE OVEN EXTREMELY DANGEROUS TO WORK ON OR AROUND WHEN THE OVEN IS ENERGIZED.**

For this reason, most manufacturers pointedly warn that **MEASURING THE HIGH VOLTAGE IS NEITHER NECESSARY NOR ADVISABLE.**

Microwave Oven Parts Suppliers/ Manufacturer Contacts

SUBMIT your REPAIR TIP

Glossary of Electronic and Microwave Oven Related Terms

Microtech Home Page

Microwave Oven FiX Finder Case History Database

CD-ROM Home Page

CD-ROM Sampless

Search Our Website

Ordering Information

Send email

Microwave Oven FAQ

Related Links

About the author, J. Carlton Gallawa

- It's better (and safer) to avoid making *live tests* if possible. If such tests become necessary, and if you are adequately qualified to do so, the test can be performed safely as follows:

1. Make sure the oven is unplugged and that the capacitor discharged.
2. Attach the meter leads to the prospective test points with insulated clip leads.
3. Then step back, plug in the oven, perform the test and observe the meter.
4. In addition, use only one hand whenever possible. Try putting the other hand behind your back or in your pocket. (Two hands could complete a circuit through your body. Use only one hand and/or an insulated tool, even when the unit is unplugged).

- After any adjustment or repair on a microwave oven, manufacturers require that a final microwave leakage check be performed to ensure that the unit does not emit excessive radiation.

RF leakage test procedure:

1. If there is evidence that the unit has been previously tampered with by someone of questionable competence, be prepared to check the leakage *before* energizing the oven.
2. Most amateurs, and many professionals, do not own an RF leakage meter. These meters are available at appliance and electronic parts suppliers, ranging in price from about $10.00 up to many hundreds of dollars for the certified models used at the professional level.
3. Inexpensive RF detection devices are also available at many retail stores such as Walmart and Radio Shack.
4. In lieu of purchasing a certified RF leak checker, you can take your repaired unit to a factory authorized servicer who will very likely check the leakage for free.

- Do not work alone. Make sure another person is nearby in case of an emergency.
- Use care when lifting and carrying a microwave oven. Remember, most of the weight is usually on one side (the control panel side).

1. When lifting a microwave oven, keep your back straight and use your legs, not your back, to do the lifting.
2. Before carrying, secure the power cord and insure a clear path to your destination.
3. When lifting an oven in or out of an automobile, *lift* it on to the seat--*do not slide it*. Better yet, place a piece of cardboard on the seat first.

- Remove your watch and other jewelry.

1. Watches that are susceptible to magnetism will be damaged by the intense magnetic field surrounding the magnetron tube.
2. Jewelry is electrically conductive and serious injury could result.

- Wear rubber soled shoes.
- Never defeat or tamper with the safety interlock switches or the fuse.
- Do not touch printed circuit board components or circuitry unless you are properly

Copyright © Information

Microwave Oven Parts Suppliers/ Manufacturer Contacts

SUBMIT your REPAIR TIP

Glossary of Electronic and Microwave Oven Related Terms

Microtech Home Page

Microwave Oven FiX Finder Case History Database

CD-ROM Home Page

CD-ROM Samples

Search Our Website

Ordering Information

Send email

grounded.

1. Static electricity can damage certain static sensitive components.

- Be aware that opening or otherwise modifying your equipment may void any manufacturer's warranty.

If you fully understand these precautions and are prepared to carefully observe them, proceed to the Master Repair Database.

If you are uneasy or unsure about any of these safety procedures, or feel uncertain as to their importance, it would probably be in your best interest to leave the repair to a qualified professional.

Disclaimer: *The author assumes no liability for any incidental, consequential or other liability from the use of this information. All risks and damages, incidental or otherwise, arising from the use or misuse of the information contained herein are entirely the responsibility of the user.*
Although careful precaution has been taken in the preparation of this material, we assume no responsibility for omissions or errors.

You are visitor number 90695

How To Check the Output Power (wattage) of a Microwave Oven

© 1996 J. Carlton Gallawa . All Rights Reserved Worldwide

Over the years manufacturers have used several different methods to rate the output wattage of microwave ovens. First, there was the *traditional* method. Then, in 1989-90 came the *JIS* (Japanese Industrial Standard). Using the JIS method, ovens rated at 700 watts using the *traditional* method became 750-watt ovens. In 1990-91 the industry changed to the international *IEC-705* standard. This pushed the wattage ratings even higher. For example, models rated at 700 *traditional* watts were instantly turned into 800-watt ovens using the IEC-705 formula.

The following test will provide a suitably accurate measurement of the output power of any microwave oven. Variations or errors in performing this test will produce uncertain results. If the line voltage (from the electrical outlet) is low, the magnetron output will be correspondingly low.

Equipment needed:

- Microwave safe container with 1000 mL (1 Liter) gradation.
- Fahrenheit thermometer (Amana part # R0157397), or centigrade thermometer (Amana part # M95D5)

Procedure:

1. Pour exactly 1000 mL (1 Liter) of cool tap water into he container. Using the thermometer, stir the water, then measure and record the temperature. For accurate results the water should be about 60 degrees F (20 degrees C).
2. Place the container on the center of the oven cooking shelf (do not leave the thermometer in the container and remove any metal racks), and heat the water (at full power) for 63 seconds. Use the second hand of a watch, not the oven timer.
3. After the heating time is completed, immediately remove the container, stir the water, re-measure and record the temperature of the heated water.
4. Subtract the starting water temperature (step 2) from the ending water temperature (step 3) to obtain the temperature rise.
5. To determine the output power in watts, multiply the total temperature rise by a factor of:
   38.75 , if you're using a Fahrenheit thermometer;
   70 , if you're using a centigrade thermometer.

Dual Magnetron Systems

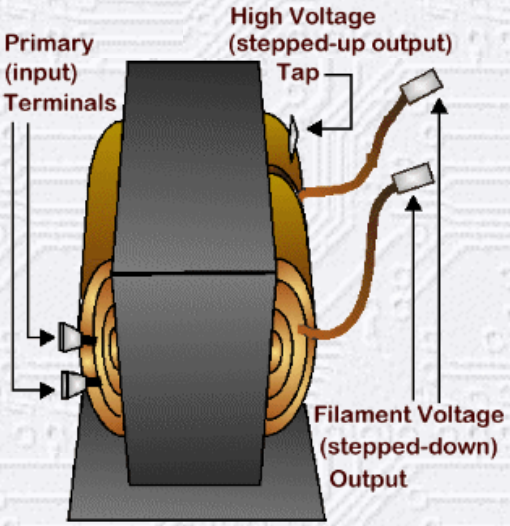
Most of the higher-powered commercial models use two 700-watt magnetron tubes, each with their respective high-voltage systems, which produces an output of 1400 watts. *Amana's* new RC22, DQ22 and MC22 models use three magnetrons to produce a 2200 watt output.

In order to evaluate the independent operation of each individual magnetron, the systems must first be isolated. This is accomplished by disabling one side, then performing an output power test on the functioning side. Either side may be disabled first.

WARNING:

Before touching components or wiring:Make sure the oven is unplugged.
DISCHARGE ALL HIGH VOLTAGE CAPACITORS. Procedure

There is high voltage present, with high-current capabilities, in the circuits of the high voltage section. It is extremely dangerous to work on or near these circuits with the oven energized. DO NOT TOUCH components or wiring while the oven is operating. Use very great caution at all times.



Typical High Voltage Transformer

The procedure is as follows. Observing the above safety precautions, first disable one side by carefully disconnecting one or both of the leads from the primary side of the high voltage transformer. (See the illustration to the right). Set the oven to cook at full power and do an output wattage check as outlined above. Having established the functional status of the one side, unplug the oven, discharge the high-voltage capacitors, re-connect the transformer primary wires, and repeat the procedure for the other side.

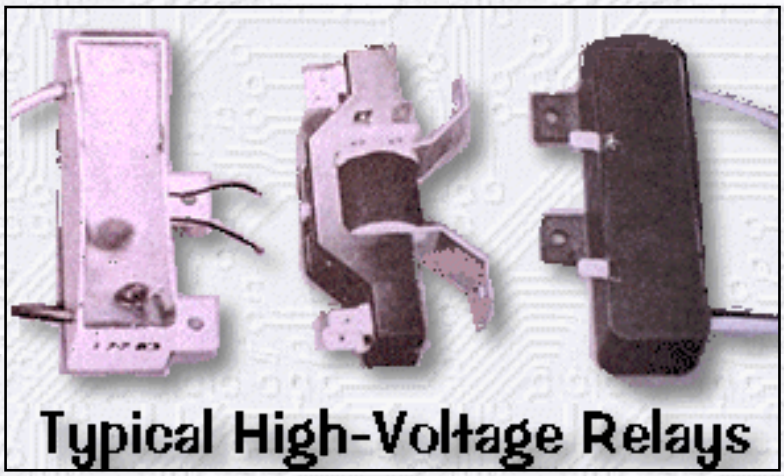
BACK SELECT BRAND HELP via EMAIL SAFETY INFORMATION HOME CD-ROM

The High Voltage Relay Used In Microwave Ovens

© 1996-2002 J. Carlton Gallawa . All Rights Reserved Worldwide

The high voltage relay , also called the *variable power switch*, is a special type of relay. It is operated by the control panel, but it performs its switching in the high voltage section.

Most models of microwave ovens control the output power by governing the on-off time of the magnetron tube. This is most commonly done by cycling on and off the line voltage that is applied to the primary side of the high-voltage transformer. Models that use a high voltage relay accomplish this power control by actually switching the high voltage on and off. This is quite a feat for this little reed relay, so it relies on very carefully timed signals from the control panel.


Typical High-Voltage Relays

The high voltage relay can experience two basic types of failures:1) An open operating coil, 2) A structural breakdown resulting in internal arcing and sometimes a crippling backfeed of current to the control panel.

Important Safety Information

Working on a microwave oven is a very dangerous task. Therefore, BEFORE performing any tests, troubleshooting or repairs, for your personal safety, we strongly urge you to carfully read, fully understand and be prepared to follow the very important safety precautions found by clicking here .

Please read the disclaimer at the bottom of this page.

How To Test The High Voltage Relay

1. **Unplug the oven.**

2. **DISCHARGE ALL HIGH VOLTAGE CAPACITORS. Procedure**
3. **First examine the relay for physical defects, such as cracks in the glass, or a smoky appearance. Check the casing for lacerations or blistering.**
4. **Carefully remove all attached leads.**
5. **With the ohmmeter set to the appropriate scale, measure across the relay coil for a normal resistance of about 200 to 400 ohms, depending on the brand.**
6. **Set the meter to the highest resistance scale and make the following measurements:**
    - **From one contact terminal (or wire) to the other**
    - **From each contact terminal to each coil terminal**
    - **From each of the four terminals to chassis ground**

A reading of less than infinity on any of these measurements indicates that the relay is defective and should be replaced. Before doing so, however, it would be good to first inspect the relay-drive circuit on the control panel for damaged components. Control panel repairs might also be necessary.

Send us E-mail: microtech@gallawa.com

You can enhance your level of expertise. See this and hundreds of other professional tests and troubleshooting procedures clearly demonstrated and explained in Microtech's comprehensive new CD-ROM:

THE COMPLETE MICROWAVE OVEN SERVICE HANDBOOK: Operation, Maintenance, Troubleshooting and Repair

Copyright © Information

Unless otherwise noted, all materials at this cite (including without limitation all text, html markup, graphics, and graphic elements) are copyrighted © 1989-2002 by J. Carlton Gallawa. The material available through this site may be freely used for attributed *noncommercial educational* purposes only. We ask that due credit and notification be given the author.

All materials appearing on this website may not be reproduced, stored in any retrieval system, or used in any way for commercial purposes without the express prior written permission of the copyright holder.

Send correspondence to: Microtech, P.O. Box 940, Gonzalez, Florida 32560

Disclaimer: ***The author assumes no liability for any incidental, consequential or other liability from the use of this information. All risks and damages, incidental or otherwise, arising from the use or misuse of the information contained herein are entirely the responsibility of the user. Although careful precaution has been taken in the preparation of this material, we assume no responsibility for omissions or errors.***

BACK | SELECT BRAND | HELP via EMAIL | SAFETY INFORMATION | HOME | CD-ROM

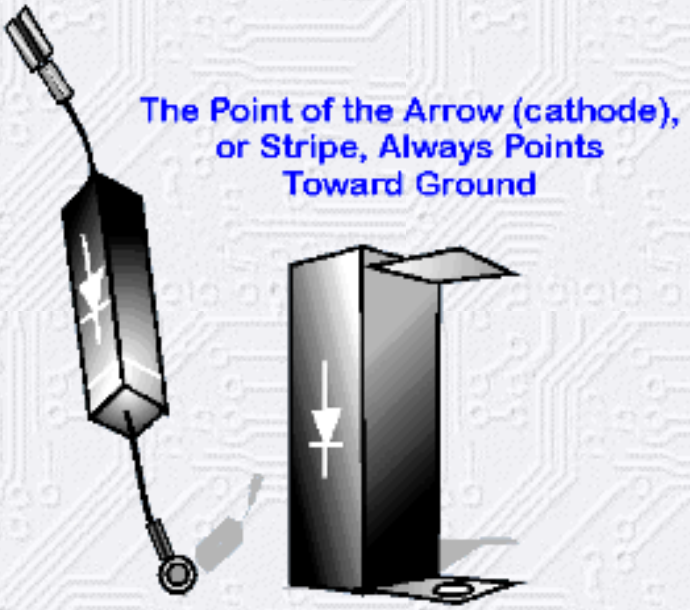
How To Test the High Voltage Rectifier (Diode)

© 1996-2001 J. Carlton Gallawa . All Rights Reserved Worldwide

The high-voltage rectifier (diode) works along with the high-voltage capacitor to effectively double the already-high voltage that is provided by the power transformer. This powerful voltage, about 3000 - 5000 volts DC (depending on the model), is applied to the magnetron tube, causing it to produce the microwave energy that cooks the food.

This test requires an ohm meter with at least a 6 volt battery in order to accurately measure the front to back resistance of the diode. Meters with insufficient battery power may read infinite resistance (open) in each direction, mistakenly showing a good diode as being open.

However, the following resistance tests will conclusively reveal a diode that is shorted. In most cases, defective diodes, whether shorted or open, will show some physical signs of the defect, such as a burned crack, a blistered spot, or it may even be split in two. Also, a shorted diode will usually give off a pungent electrical burning odor.



Common High-Voltage Diodes (Rectifiers)

Before making this or any other test:

ALWAYS MAKE SURE THE OVEN IS UNPLUGGED AND THE HIGH VOLTAGE CAPACITOR IS FULLY DISCHARGED

Important Safety Information

Microwave ovens are one of the most dangerous appliances to work on. Before attempting any troubleshooting, testing or repairs, for your personal safety we strongly urge you to carefully read the very important safety precautions found by clicking here .

Please read our disclaimer at the bottom of this page.

Test 1

1. Unplug the oven.
2. **DISCHARGE ALL HIGH VOLTAGE CAPACITORS. (Procedure)**
3. Carefully remove the lead that goes to the capacitor (the ground connection may remain attached)
4. Set the ohmmeter to read ohms at a scale of R X 10,000 or higher.
5. Measure the resistance across the terminals of the diode by touching the positive meter probe to the anode and the negative probe to the cathode (the cathode is the side that goes to ground, usually marked by an arrow, dot or stripe).
6. A normal diode, depending on make and model, should read about 50,000 to 200,000 ohms. (Note:The polarity of the meter probes, with regard to forward and reverse bias readings, may be relative to the type of meter being used.)
7. Reversing the leads should produce a reading of infinity (open), unless there is a bleeder resistor across the diode, in which case the reading would show the [megohm] value of the resistor.
8. If continuity is read in both directions, the diode is shorted. If infinity is read in both directions, the diode is open. In each case the diode must be replaced.

In some models the diode is located inside of the high voltage capacitor. In this case, identify the diode terminal and perform the same test as above, measuring from the diode terminal to the capacitor's metal case.

We welcome your comments and suggestions: **j.gallawa@cox.net**

Find out what makes a microwave oven tick. You will see the above test and numerous other procedures clearly explained, plus hundreds of other tips and "tricks of the trade" in Microtech's authoritative, "all-in-one" CD-ROM:

The COMPLETE MICROWAVE OVEN SERVICE HANDBOOK on CD-ROM v. 2001

CLICK

Copyright © Information

Unless otherwise noted, all materials at this cite (including without limitation all text, html markup, graphics, and graphic elements) are copyrighted © 1989-2001 by J. Carlton Gallawa. The material available through this site may be freely used for attributed ***noncommercial educational*** purposes only. We ask that due credit and notification be given the author.

All materials appearing on this website may not be reproduced, stored in any retrieval system, or used in any way for commercial purposes without the express prior written permission of the copyright holder.

Send correspondence to: **Microtech, P.O. Box 940, Gonzalez, Florida 32560**

Disclaimer: *The author assumes no liability for any incidental, consequential or other liability from the use of this information. All risks and damages, incidental or otherwise, arising from the use or misuse of the information contained herein are entirely the responsibility of the user. Although careful precaution has been taken in the preparation of this material, we assume no responsibility for omissions or errors.*

As of 4/10/98 you are visitor number 48588

How To Test the High Voltage Capacitor

© 1996-2001 J. Carlton Gallawa . All Rights Reserved Worldwide

The high-voltage capacitor works along with the high-voltage diode to effectively double the already-high voltage from the secondary (output) winding of the power transformer. This high DC voltage provides the boost necessary to fire the magnetron into oscillation. The capacitor can hold a fearsome electrical charge long after the oven has been unplugged. So before making this or any other test:

ALWAYS MAKE SURE THE OVEN IS UNPLUGGED AND THE HIGH VOLTAGE CAPACITOR IS FULLY DISCHARGED

Microwave ovens are among the most dangerous appliances to work on. Before attempting any troubleshooting, testing or repairs, for your personal safety we strongly urge you to carefully read the very important safety precautions found by clicking here .

Please read our disclaimer at the bottom of this page.

Typical High-Voltage Capacitor

How To Dishcarge The High Voltage Capacitor

The capacitor is discharged by creating a short circuit (direct connection) between the two capacitor terminals and from each terminal to chassis ground (bare metal surface).

a. Do this by touching the blade of an insulated-handled screw driver to one terminal, then slide it toward the other terminal until it makes contact and hold it there for a few seconds. (This can result in a rather startling "pop!" Note:If there is a spark, the capacitor is evidently holding a charge, thus it is most likely not defective)
b. Repeat the procedure to create a short between each capacitor terminal and chassis ground.
c. If the capacitor has three terminals, use the same procedure to create a short circuit between each terminal and then from each terminal to ground.

d. Older Amana-made models (generally those manufactured before 1977) have red, round filter capacitors mounted in the base of the magnetron tube which can also hold a charge. Ground each magnetron terminal by creating a short circuit to chassis ground using the blade of a screwdriver as explained above.

Capacitor Test Procedure

1. Unplug the oven.
2. DISCHARGE ALL HIGH VOLTAGE CAPACITORS.
3. Note the wiring and carefully remove all leads from the capacitor terminals. (If there is a bleeder resistor, it need not be removed. But, bear in mind that some measurements will reflect the meg-ohm resistance of the resistor)
4. Set the ohmmeter to its highest resistance scale.
5. Measure from one terminal to the other for a normal reading of infinity (or the value of the bleeder resistor).
6. Now reverse the leads. The meter should momentarily deflect toward the zero mark, then slowly drift back to infinity.
7. Reverse the leads once again. This should produce the same meter deflection.
8. Next measure from each terminal to the capacitor's metal case for a normal reading of infinity. (If there is an internal diode, the meter readings will reflect the diode's forward bias resistance. (See HV diode test procedure)
9. A visual inspection will also reveal certain defects, such as:
    - Evidence of arcing or burning at the insulators
    - The presence of an oily film or smell suggests a dielectric (non-conductive medium) leak
    - A bulging case indicates dielectric breakdown

Any such defects or abnormal readings would require replacement of the capacitor

Send us E-mail: **microtech@gallawa.com**

Would you like to learn more? Here is Microtech's acclaimed textbook on CD-ROM! Widely recommended by electronic & appliance repair shops, technical students and do-it-yourselfers. You get up-to-the-minute service information. Explore, component by component, how microwaves work, how they fail, and how to make safe, profitable repairs.

The COMPLETE MICROWAVE OVEN SERVICE HANDBOOK on CD-ROM v. 2001

BACK | SELECT BRAND | HELP via EMAIL | SAFETY INFORMATION | HOME | CD-ROM

Copyright © Information

Unless otherwise noted, all materials at this cite (including without limitation all text, html markup, graphics, and graphic elements) are copyrighted © 1989-2001 by J. Carlton Gallawa. The material available through this site may be freely used for attributed ***noncommercial educational*** purposes only. We ask that due credit and notification be given the author.

All materials appearing on this website may not be reproduced, stored in any retrieval system, or used in any way for commercial purposes without the express prior written permission of the copyright holder.

Send correspondence to: **Microtech, P.O. Box 940, Gonzalez, Florida 32560**

Disclaimer: ***The author assumes no liability for any incidental, consequential or other liability from the use of this information. All risks and damages, incidental or otherwise, arising from the use or misuse of the information contained herein are entirely the responsibility of the user. Although careful precaution has been taken in the preparation of this material, we assume no responsibility for omissions or errors.***

You are visitor number 47486. *Thanks for stopping by...*

The Microwave Oven Voltage-Doubler Circuit

Theory of Operation

Excerpts from the book ***The Complete Microwave Oven Service Handbook***
--NOW available on CD-ROM (***CLICK HERE***)
and from the video ***You Can Fix Your Microwave Oven, Plus VCR Know-How***
Copyright ©, 1997-99 by J. Carlton Gallawa

Music of Claude Debussy for your listening enjoyment.
(Use right mouse button on note icon to start and control music)

In the high-voltage section of a microwave oven, the diode (rectifier) and the capacitor function together to effectively double the already-high voltage. This is called a voltage-doubler circuit.

In order to effectively understand the voltage-doubler circuit used in microwave ovens, it is first necessary to understand the difference between *effective* voltage and *peak* voltage. Measured with a common voltmeter, the voltage in the standard household receptacle is 115 VAC (± 10%). The actual voltage alternates through one complete cycle every 60th of a second, as shown in the sine wave of **Figure 1** . Because the voltage is continuously varying, the value reflected on the voltmeter is only the *effective* value of this voltage. The sign wave actually reaches a *peak* value of 1.414 times the effective value. So the peak voltage at a standard wall outlet would be:

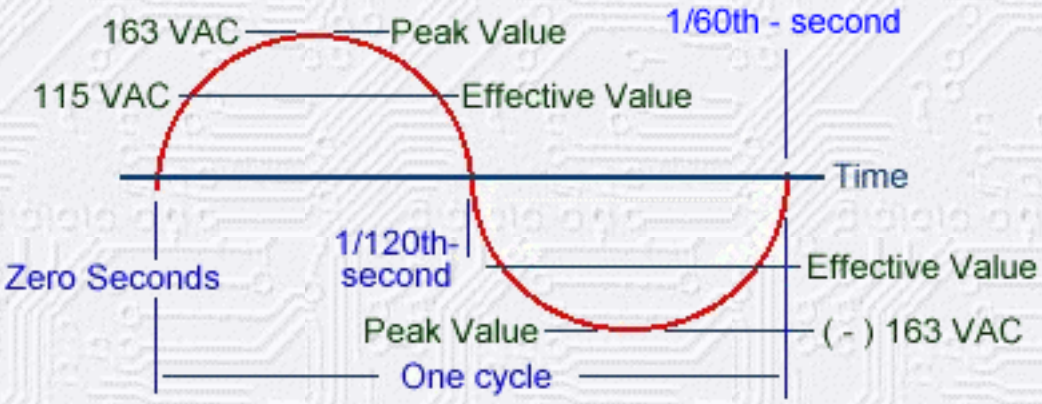


Figure 1 60 HZ sine wave

Peak voltage = **1.414** X **115 VAC** = **163 VAC**

Knowing peak values and their relationship to effective values is important to understanding the operation of a voltage-doubler circuit.

Voltage-doubler circuits are fed with the stepped-up AC voltage from the high-voltage transformer's secondary (or output) winding. Typically, a transformer would step up 115 volts to about 2000 volts, which would have an approximate peak value of 2800 volts. We will use this value in analyzing the operating sequence of a voltage doubler. Please note that the values of voltages shown are peak, no-load, theoretical values. Under actual circuit operation, the load of the magnetron tube may decrease the output of the voltage doubler by as much as 40 percent.

The Half-Wave Voltage Doubler

Refer to **Figure 2A** . During the first positive half-cycle, which is designated on the sine wave graph as **T1** , the voltage from the transformer increases accordingly with the polarity shown. The current flows in the direction of the arrows, charging the capacitor through the diode.

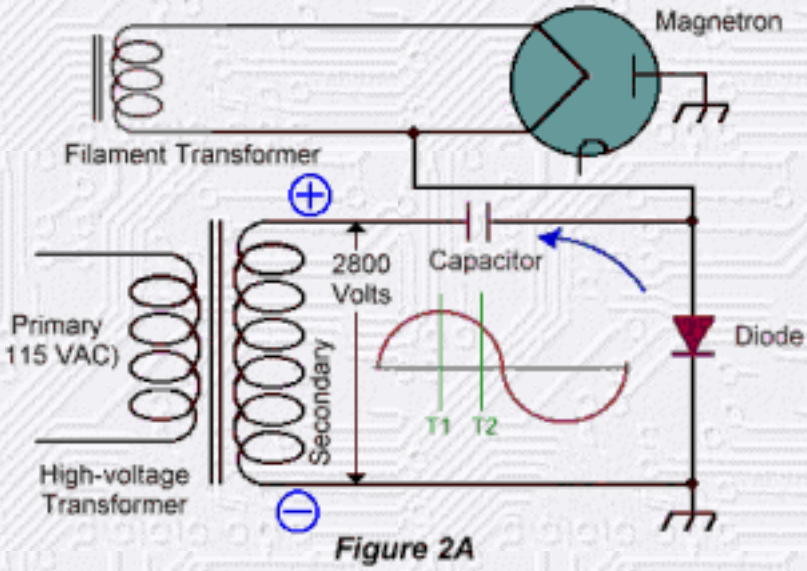


Figure 2A

During the capacitor charging time there is no voltage to the magnetron because the current takes the course of least resistance. In other words, rather than take a path through ground and up to the plate of the magnetron, the current swings up through the diode. The voltage across the capacitor will rise to the transformer secondary voltage to the maximum 2800 volts. As the transformer secondary voltage begins to decrease from its maximum positive value (at time increment **T2** on the sine wave graph), the capacitor will attempt to discharge back through the diode. The diode is like a one-way street in that it will not conduct in this direction. Thus, the discharge path is blocked, and the capacitor remains charged to the 2800 volts.

Refer to **Figure 2B** . At time **T3** , the transformer secondary (output) voltage swings into the negative half-cycle and increases in a negative direction to a *negative* 2800 volts, with polarities as shown. The transformer secondary and the charged capacitor are now essentially

two energy sources in series. The 2800 volts across the transformer winding adds to the 2800 volts stored in the capacitor and the sum voltage of 5600 volts is applied to the magnetron cathode .

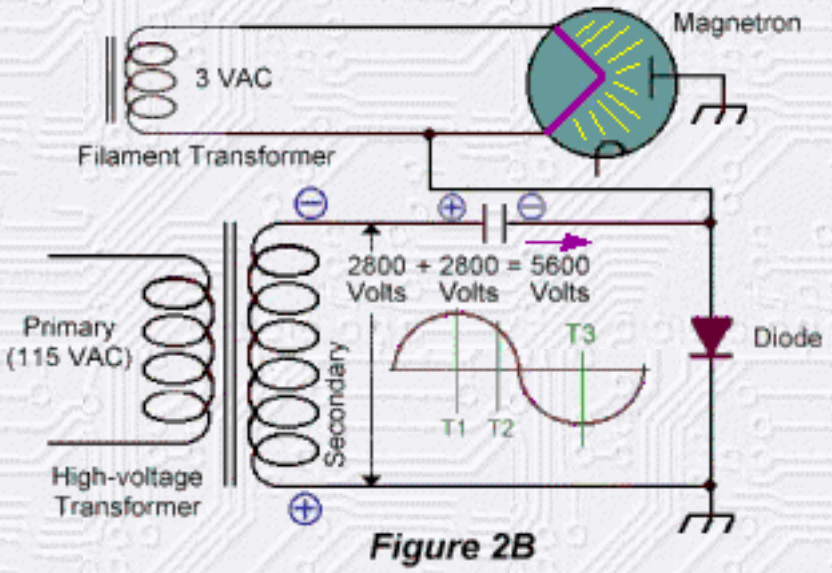


Figure 2B

There are two fundamental characteristics of this 5600-volt output that should be noted. First, because a voltage doubler is also a rectifier, the output is a DC voltage. Second, the resulting output voltage that is applied to the magnetron tube is actually a *pulsed* DC voltage. This is because the doubler generates an output only during the negative half-cycle of the transformer's output (secondary) voltage. So, the magnetron tube is, in fact, pulsed on and off at a rate of 50 or 60 times per second, depending on the frequency of the line voltage.

A Word of Warning

The circuits described here ***cannot be measured with a normal voltmeter*** . The powerful voltages combined with the high-current potential make these circuits deadly in nature. If you wish to measure the high voltage, you should first make sure that all your affairs are in order and that your life insurance policy covers death by electrocution. If you still want to measure the high voltage, a special high-voltage meter with special leads ***must*** be used. **HIGH VOLTAGE SAFETY PROCEDURES MUST BE CAREFULLY OBSERVED** .

However, microwave oven problems can be diagnosed just as conclusively, and certainly more safely without checking the high voltage. Therefore, **MEASURING THE HIGH VOLTAGE IS STRONGLY DISCOURAGED.**

Copyright Information
Unless otherwise noted, all materials at this cite (including without limitation all text, html markup, graphics, and graphic elements) are copyrighted ©, 1989-99 by J. Carlton Gallawa.
The material available through this site may be freely used for attributed ***noncommercial educational*** purposes only. We ask that due credit and notification be given the author.

All materials appearing on this website may not be reproduced, stored in any retrieval system, or used in any way for commercial purposes without the express prior written permission of the copyright holder.

Send correspondence to: **Microtech, P.O. Box 940, Gonzalez, Florida 32560**

Disclaimer: *The author assumes no liability for any incidental, consequential or other liability from the use of this information. All risks and damages, incidental or otherwise, arising from the use or misuse of the information contained herein are entirely the responsibility of the user. Although careful precaution has been taken in the preparation of this material, we assume no responsibility for omissions or errors.*

| Back | Send Email | Top of Page | Home Page | Microwave Oven Video |

You are visitor number 55962

The Magnetron Tube

Structure and Operation

Excerpts from the book ***The Complete Microwave Oven Service Handbook***
--NOW available on CD-ROM (***CLICK HERE***)
Copyright ©, 1989-2001by J. Carlton Gallawa
and from the video ***You Can Fix Your Microwave Oven, Plus VCR Know-How***

Debussy's L'Îsle Joyeuse for your listening enjoyment.
(Use right mouse button on note icon to start and control music)

The heart of every microwave oven is the **high voltage system** . Its purpose is to generate microwave energy. The high-voltage components accomplish this by stepping up AC line voltage to high voltage, which is then changed to an even higher DC voltage. This DC power is then converted to the RF energy that cooks the food.

Basic Magnetron Structure

The nucleus of the high-voltage system is the **magnetron tube** . The magnetron is a diode-type electron tube which is used to produce the required 2450 MHz of microwave energy. It is classed as a diode because it has no grid as does an ordinary electron tube. A magnetic field imposed on the space between the *anode* (plate) and the *cathode* serves as the grid. While the external configurations of different magnetrons will vary, the basic internal structures are the same. These include the *anode,* the *filament/cathode,* the *antenna,* and the *magnets*

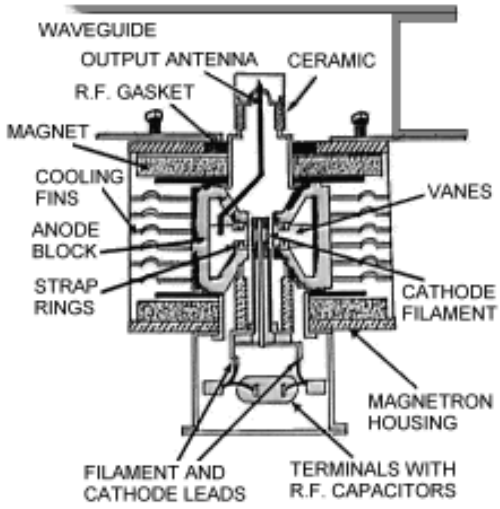


Figure 1 Sectional view of a typical magnetron (Courtesy of Michael S. Wagner)

The ***ANODE*** (or plate) is a hollow cylinder of iron from which an even number of anode vanes extend inward (see Fig. 2). The open trapezoidal shaped areas between each of the vanes are *resonant cavities* that serve as tuned circuits and determine the output frequency of the tube. The anode operates in such a way that alternate segments must be connected, or strapped, so that each segment is opposite in polarity to the segment on either side. In effect, the cavities are connected in parallel with regard to the output. This will become easier to understand as the description of operation is considered.

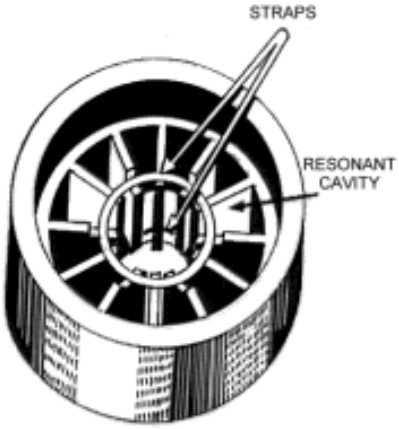
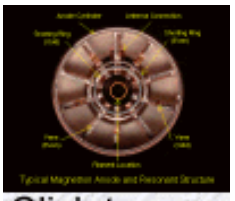


Fig. 2 Typical anode vane block
(Courtesy of Michael S. Wagner)



The ***FILAMENT*** (also called heater), which also serves as the ***cathode*** of the tube, is located in the center of the magnetron, and is supported by the large and rigid filament leads, which are carefully sealed into the tube and shielded.

The ***ANTENNA*** is a probe or loop that is connected to the anode and extends into one of the tuned cavities. The antenna is coupled to the waveguide , a hollow metal enclosure, into which the antenna transmits the RF energy.

The ***MAGNETIC FIELD*** is provided by strong permanent magnets, which are mounted around the magnetron so that the magnetic field is parallel with the axis of the cathode.

Basic Magnetron Operation

The theory of magnetron operation is based on the motion of electrons under the combined influence of electric and magnetic fields. For the tube to operate, electrons must flow from the cathode to the anode. There are two fundamental laws that govern their trajectory:

1. The force exerted by an electric field on an electron is proportional to the strength of the field. Electrons tend to move from a point of negative potential toward a positive potential. **Figure 3-A** shows the uniform and direct movement of the electrons in an electric field with no magnetic field present, from the negative cathode to the positive anode.
2. The force exerted on an electron in a magnetic field is at right angles to both the field itself, and to the path of the electron. The direction of the force is such that the electron proceeds to the anode in a curve rather than a direct path.

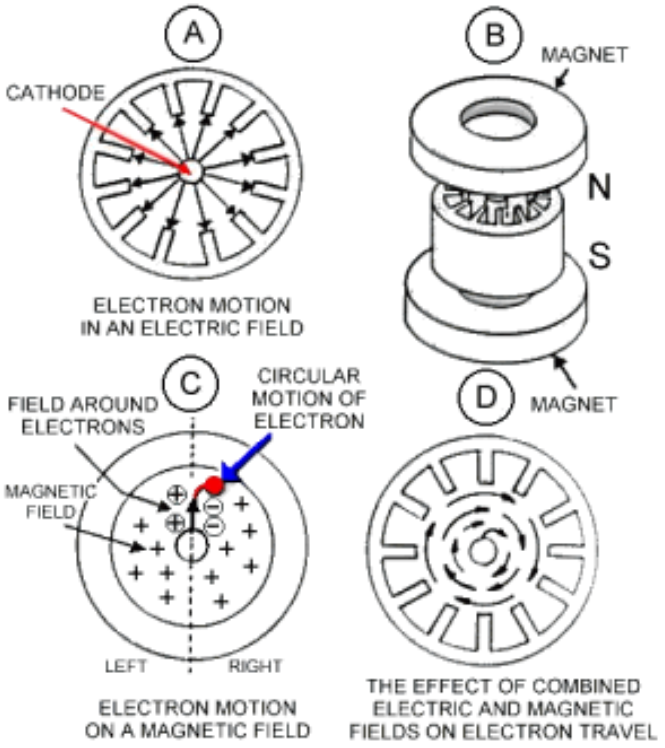


Figure 3 Electron motion in a magnetron tube
(Courtesy of Michael S. Wagner)

Effect of the Magnetic Field

In **Figure 3-B** two permanent magnets are added above and below the tube structure. In **Figure 3-C,** assume the upper magnet is a north pole and you are viewing from that position. The lower, south pole magnet, is located underneath the page, so that the magnetic field appears to be coming right through the page. Just as electrons flowing through a conductor cause a magnetic field to build up around that conductor, so an electron moving through space tends to build up a magnetic field around itself. On one side (left) of the electron's path, this self induced magnetic field adds to the permanent magnetic field surrounding it. On the other side (right) of its path, it has the opposite effect of subtracting from the permanent magnetic field. The magnetic field on the right side is therefore weakened, and the electron's trajectory bends in that direction, resulting in a circular motion of travel to the anode.

The process begins with a low voltage being applied to the filament, which causes it to heat up (filament voltage is usually 3 to 4 VAC, depending on the make and model). Remember, in a magnetron tube, the filament is also the cathode. The temperature rise causes increased molecular activity within the cathode, to the extent that it begins to "boil off" or emit electrons. Electrons leaving the surface of a heated filament wire might be compared to molecules that leave the surface of boiling water in the form of steam. Unlike steam, though, the electrons do not evaporate. They float, or hover, just off the surface of the

cathode, waiting for some momentum.

Continued on Page Two

| Back | Send Email | Top of Page | Home Page | FREE samples: The Complete Microwave Oven Service Handbook

Copyright Information

Unless otherwise noted, all materials at this cite (including without limitation all text, html markup, graphics, and graphic elements) are copyrighted ©, 1989-2001 by J. Carlton Gallawa. The material available through this site may be freely used for attributed ***noncommercial educational*** purposes only. We ask that due credit and notification be given the author.

All materials appearing on this website may not be reproduced, stored in any retrieval system, or used in any way for commercial purposes without the express prior written permission of the copyright holder.

Send correspondence to: **Microtech, P.O. Box 940, Gonzalez, Florida 32560**

Disclaimer: *The author assumes no liability for any incidental, consequential or other liability from the use of this information. All risks and damages, incidental or otherwise, arising from the use or misuse of the information contained herein are entirely the responsibility of the user. Although careful precaution has been taken in the preparation of this material, we assume no responsibility for omissions or errors.*
#127031

Available NOW on Interactive Multimedia CD-ROM

Completely Updated

The Original...

THE COMPLETE MICROWAVE OVEN SERVICE HANDBOOK

Operation, Maintenance, Troubleshooting and Repair
by J. Carlton Gallawa
Copyright © 2004

The "All-in-One" Microwave Oven Maintenance and Repair Answerbook on CD-ROM

Plus:

- **YOU GET all the information from key video segments of the acclaimed 4-hour instructional video, *The Complete Microwave Oven Service Handbook v. 2000 on CD-ROM***
- **Virtually 1000s of microwave oven repair case histories with factory approved troubleshooting and repair procedures**
- **Factory troubleshooting charts, error codes, schematics and diagnostic procedures**
- **Touch panel (key pad) matrix diagrams for 100s of brands**
- **Hundreds of vividly colored schematics, diagrams, illustrations and photos ease the toughest repair chores.**
- **Fully searchable text for quick information gathering**
- **All chapters, sections and references are hyperlinked for fast and smooth navigating**
- **FREE technical support**
- **Full 30-day, no-questions- asked, money-back guarantee**

Finally, everything you need to successfully troubleshoot and fix industrial, commercial and residential microwave ovens quickly and safely.

You'll make more money that you ever thought possible when you can find and fix problems fast!

Here is a self-paced CD-ROM-based total learning environment for anyone wanting to learn both basic and advanced features of microwave oven repair. It's packed with proven, hands-on tips, practical troubleshooting methods and 100's of time-saving diagrams. This interactive training CD-ROM will show you how to easily and accurately perform all your microwave oven servicing chores in a

What Professional Technicians Are Saying: CLICK

What's more, the CD covers individual components and devices in easy-to-find interactive sections. This helps you get the important repair facts you need when working with: high voltage components ... controllers and timers ... safety protection circuits ... cooling and energy dispersions systems ... and more.

HTML Samples
(Just click. Loads without Acrobat Reader)

- **Chapter 3 - Safety of Microwave Energy--An Objective Discussion**
- **Chapter 7 - The High-Voltage System**
- **Chapter 8 - Control Systems**
- **Chapter 13 - Troubleshooting control panel and touch panel problems**

flash.

Using a powerful combination of interactive text and vividly colored graphics, this CD-ROM course is one of the most effective training tools available.

What Professional Technicians Are Saying About The CD-ROM:

"The author covers all aspects of microwave ovens with everything from the original Amana Radar Range to the current power-cooking GE Advantium oven. There is a wealth of information to be learned from this disk. As a field technician with thousands of repairs under my belt, I was surprised with not only the amount of information that I personally learned in reviewing this guide, but also a few quick diagnostic procedures I simply didn't know existed. Not only do you get theory of operation and basic troubleshooting, but also an array of video clips, illustrations, wiring diagrams, and tips for proper repairs of both domestic and commercial models. The handbook is an easy-to-follow guide for beginners covering important safety procedures and diagnostics. It is also crafted as a unique reference for the well-seasoned journeyman. Packed with information, this CD is a must for all technicians…"
--Michael T. Maitino, Product Review, Appliance Service News, October 2001 Issue

"I must say that I am impressed. These documents are very well thought out and presented indeed. I have spent many hours studying the content of the CD and have taken the liberty of printing out the whole document and having it bound into book form so that I have a hard copy reference. The whole document is first class, as well as being superb reference material...Overall the whole document is fantastic."
--Gregory Dand, Central Coast Microwave, Gosford, Australia "Expert repair service serving the Central Coast of New South Wales with a 48-hour turnaround time."

"It's an incredible CD, obviously well thought out, clear and concise in all aspects including contact info of tool suppliers--Well done John!"
--Barry Nicholls, Bridgetown, Barbados

"After viewing this CD, all I can say is, 'WOW!' and again, 'WOW!' These were the same sentiments expressed by my experienced technician who works on microwave ovens for my business… I don't know how much this CD sells for, but it should be worth hundreds of dollars to existing microwave oven technicians or those who know very little about microwave ovens before they begin to look at this excellent CD instructional handbook."
--Captain Toolhead, Appliance Service News, October 2001 Issue

"Since I have received your CD I have fixed numerous microwaves by referring to it."
--John Kinnally, Revere, Massachusetts

1-800-700-UFIX (8349)

Use your major credit card to order your personal copy

The Complete Microwave Oven Service Handbook on CD

Operation, Maintenance, Troubleshooting & Repair 2004

Professional Edition

$79.95 - $10.00 **Internet Discount = $69.95** (Florida, USA, residents add 7% sales tax), plus $5.50 shipping and handling within continental U.S. (Cost of shipping to destinations outside of the continental U.S. varies)

home | repair database | order info | video | author | e-mail

Copyright © 1989 - 2004 by John C. Gallawa. All Rights Reserved Worldwide

You are visitor number 88115

Actual Dissected Magnetron Tube

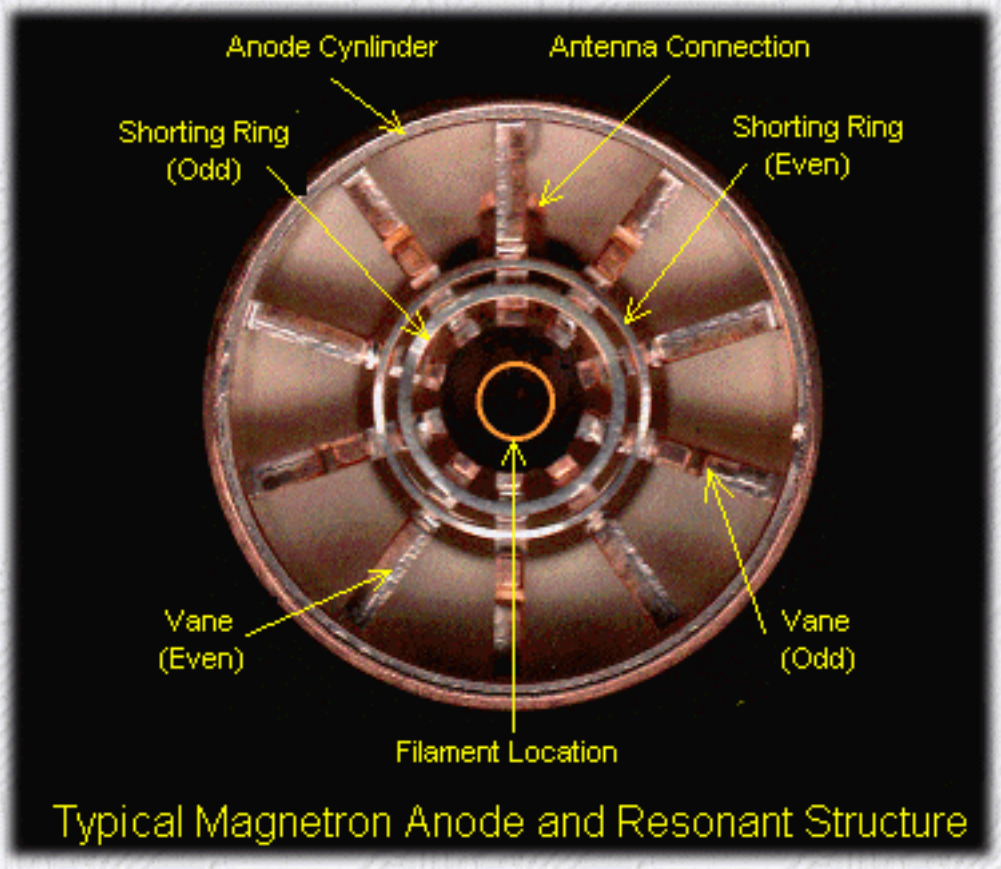


Photo courtesy of Sam Goldwasser:Sci.Electronics.Repair FAQ: http://www.repairfaq.org/

| Back | Send Email | Top of Page | Home Page |

-From the book on CD-ROM,

The COMPLETE MICROWAVE OVEN SERVICE HANDBOOK
Operation, Maintenance, Troubleshooting and Repair

Copyright © 1989-2000 J. Carlton Gallawa . All Rights Reserved Worldwide
▸ CLICK FOR MORE

Safety of Microwave Energy —An Objective Discussion

Chapter Three

3.1 INTRODUCTION

In 1926, Soviet naturalist Vernadskii wrote, "We are surrounded and penetrated, at all times and at all places, by eternally changing, combining, and opposing radiations of different wavelengths." He was referring to electromagnetic radiation emanating from the sun and other sources in earth's galaxy that finds its way into our atmosphere. Vernadskii had no way of knowing that within fifty years his observation would apply as well to radiation generated here on earth by his fellow man. —Paul Brodeur, *The Zapping of America*, (Norton, 1977) p. *15*.

Since the development of radar, man's ability to generate and harness microwaves has resulted in such a proliferation of devices using microwaves that today virtually everyone on earth is affected by them to some degree. Some environmentalists call it "electronic smog," and one United States government agency warned that the levels Americans are exposed to every day, without even being aware of it, may be dangerous.

Particularly in some urban areas, microwave and related radiation is estimated to be up to a billion times or more as great as that which naturally exists in the environment. And sources of this kind of radiation are increasing rapidly.

Airports have navigational systems that use microwaves, and police radar operates on microwave frequencies. Television, telephone, and computer signals are transmitted by microwaves. Broadcasting, surveillance, and communications satellite systems utilize microwaves, as do some air pollution monitoring systems. Motorist-aid call boxes along the highway, many burglar alarm systems, and some automatic garage door openers work because of microwaves.

The world of medicine uses them for sterilization, to retard tumor growth, and to treat sore muscles. Industry and science each have their own uses for microwaves. Researchers in Canada have developed an aircraft that can stay aloft for months at a time without fuel. The plane is powered by electricity, which is beamed up as microwave energy, then converted back into electrical energy, which powers the engine. The military, by far the largest users of microwave devices in today's world of electronic warfare, employ microwaves for such things as guidance systems for nuclear missiles and antimissile missiles, range finders for tanks, and for eavesdropping.

The Soviets allegedly used microwaves to irradiate the American Embassy in Moscow. Conversely, American warships would, reportedly, pull alongside Russian surveillance trawlers on the high seas, turn on their radars at full megawatt power, and "paint" the Soviet vessels with radiation. This would burn out the trawlers' electronic listening devices, and probably accounts for the fact that Russian sailors were seldom seen on deck. — Paul Brodeur, *The Zapping of America*, (Norton, 1977) p. 308.

This era of *energy pollution* has brought about growing concern regarding the potential risks involved in exposure to low-level microwave radiation, in particular from microwave ovens, the most common consumer use of microwave energy. With the skyrocketing popularity of microwave ovens, some are seriously questioning the wisdom of bringing these microwave-emitting devices into our homes when the effects of microwaves on the human system are not yet completely understood. Extensive research that began particularly in the mid-1970's in the United States, and as far back as the 1930's in Russia, is now rendering some interesting and controversial results.

3.2 MICROWAVES—HOW DANGEROUS ARE THEY?

If microwaves in an oven can cook a piece of beef, they will also have the same effect on human tissue if exposed to high enough intensities for a long enough period of time. Certain body organs are particularly sensitive to this *thermal* effect. Thermal means heat. Just as it is the heat produced by a hot stove that causes the careless cook to voice a sudden unsavory expletive, so too, it is the heat generated by the microwaves that creates the hazard in this case. For example, if the lens of the eye were exposed to excessive heat from microwaves, its circulatory system would be unable to provide sufficient cooling, and it would cook like the white of an egg. Exposure to high levels of microwaves can cause cataracts. Also, the stomach, intestines and bladder are especially sensitive to thermal damage from high levels of microwaves. Likewise, the testes are very sensitive to changes in temperature, since sperm can be formed only at temperatures lower than that of the body itself. Thus, accidental exposure to high levels of microwave energy can alter or kill sperm, producing temporary sterility. The question is: How intense would levels of microwave energy have to be to create such a danger?

3.3 MEASURING MICROWAVES

The power density of microwaves is determined by measuring the amount of energy that flows

through one square centimeter (a square centimeter is about the size of an aspirin tablet) of space in one second. Western scientists believed that serious injuries could result only at levels of 100 Milliwatts per square Centimeter (mw/ cm^2) or higher. It was theorized that a built in safety factor of 10 times would be a safe margin. So, in the mid-1950's a voluntary industry standard of 10 mw/cm^2 (or, one-tenth of 100 mw/cm^2) was adopted.

In 1971, due to the concern of the Department of Health, Education and Welfare (now the Department of Health and Human Services), the standard for allowable leakage from microwave ovens in the United States was set by law to the present, more stringent, levels of *1mw/cm²* (at a distance of five centimeters--see Section 15.7) prior to acquisition by a purchaser, and *5mw/cm²* thereafter. These safety standards were based on the belief that the only danger from exposure to high-intensity microwave energy was a thermal or overheating effect.

3.4 SOVIET STANDARDS

In the U.S., exposure standards were being developed mainly under the American National Standards Institute by a broad group of scientists and by representatives of users and manufacturers. While in East European countries and, in particular, Russia, the exposure standards were being determined by a specialized research institute on occupational health. Rather than concentrating on the effects of high-intensity levels, 'Soviet scientists were focusing their efforts on the lesser-known effects of prolonged or repeated exposure to low levels of microwaves. Their research, which began quite some time before that of their Western counterparts, has yielded some rather unsettling reports. Soviet studies show that long-term exposure to low levels of microwave energy could result in unpleasant effects that are not attributable to over-heating (or thermal effect) alone. These effects could be seen at exposure levels at and *below* 10mw/cm^2, which is the occupational *safety standard* in the U.S.

The USSR, and other European countries, has thus set their own strict guidelines for microwave safety, concluding that Western safety standards are simply not safe. For example, Russian workers are required to wear protective goggles any time they are temporarily exposed to a microwave radiation level of 1mw/cm^2, a level routinely allowed to leak (although in recent years, rarely does) from U.S. microwave ovens.

These reports have provoked a reexamination of Western safety standards and heightened experimentation. Several American laboratories have since found low-level exposure to microwaves to cause *cumulative* harmful effects on the eye, such as cataracts. (Cumulative means that one low-level dose in itself would not be enough to affect you, but if you add another and another, and so on, then eventually the effects would be seen.) Research also reports a reduction in personnel efficiency, and in the ability to perform certain tasks, and even a possible link to cancer. Thus, while not all the research is complete, there has been enough evidence in support of Soviet findings to likely cause an eventual toughening of U.S. standards.

3.5 WHAT ARE SAFE LEVELS OF EXPOSURE?

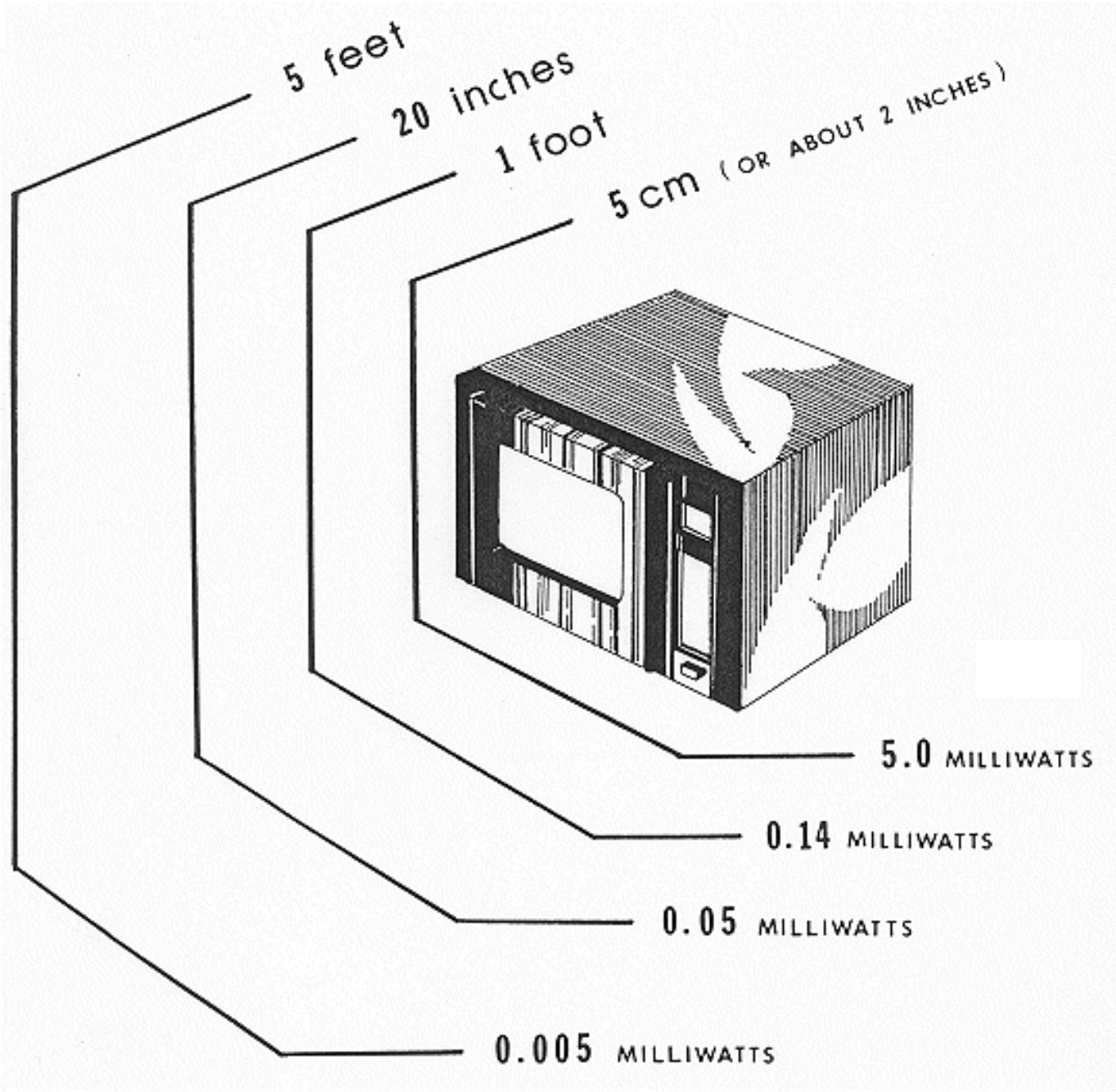
No one really knows for sure how to interpret the emerging results as painstaking experimentation continues. One thing they do know, however, is that there is a non-thermal effect from microwaves at levels that many people may be exposed to on a daily basis. What degree of danger does this non-thermal effect represent? The answer to that has to do with the controversial difference between a simple biological *effect* and a serious biological *hazard.* For example, a reduction in the ability to perform certain tasks may be the effect, but at what point does that effect constitute a hazard?

So, what are safe levels of exposure to microwaves? While vigorously warning of the invisible dangers involved with non-ionizing radiation, Dr. Milton M. Zaret, a professor of ophthalmology, and a long time student of the biological effects of microwaves, answers: "I have no idea what a safe level is, I don't think anyone in the world knows what a safe level is."

The effects of long term exposure to low levels of microwaves, and their significance to human health, will become clear only after large numbers of people who are being exposed to microwaves are studied for many years. Studies are being done with animals, but it is difficult to translate the effects of microwaves on animals to possible effects on humans. For example, researchers find it quite difficult to simulate the conditions (with animals) under which people use microwave ovens. Since no one can say with certainty what levels of exposure are safe, the course of wisdom would be, as a U.S. government spokesman pointed out, to avoid "exposure to any unneeded radiation.''

3.6 HOW FAR AWAY IS SAFE?

One pertinent characteristic of microwaves is that they disperse and dissipate very quickly in the atmosphere. For example, the maximum allowable leakage from a microwave oven (after the sale) is 5 milliwatts of microwave radiation per square centimeter at approximately 2 inches from the oven surface. However, as Figure 3-1 illustrates, as you move away from the oven, the



level of exposure to any energy that may be leaking decreases dramatically. This may be likened to holding your hand immediately above a burning candle as opposed to holding it 4, 8 or 12 inches away. Say you are standing 2 inches away from a microwave oven, and are being "zapped" by 5mw/cm^2 of microwave energy, then you wisely step back to a distance of 20 inches or roughly an arm's length. Your level of exposure would drop by a factor of 100, (the square of the distance) to .05mw/cm^2, a level compatible even with stringent Soviet standards, (present Soviet occupational standard allows up to 0.1mw/cm in no more than two hours). However, it must be noted that Czech scientists have reported some effects even at these infinitesimal levels. This, combined with the opinion of Russian scientists that microwave effects are cumulative, certainly underscores the need for consumers and servicers alike to observe certain common sense precautions.

• Stay at least an arm's length away from the front of an operating oven. This is especially so with pregnant women according to a U.S. government agency, which states

that the human fetus is "probably the most sensitive segment of the population potentially exposed to microwave radiation." Children represent another sensitive segment of the population. Never should anyone, and *especially* children, stand gazing into, or directly against an operating microwave oven.

• If the door of an oven will not close properly, is bent, warped, tampered with, or otherwise damaged in any way, DO NOT OPERATE the oven unless you are a qualified servicer with an approved RF survey meter in hand.

• Never operate an oven when it is empty. This creates a no-load condition, which can damage the oven and cause excess leakage.

• Never inactivate, interfere with, or try to adjust the built-in safety interlock system of an oven, *unless* you are properly equipped and qualified to do so. Tampering with safety interlocks would be as foolish as disconnecting the brakes on a car.

• The Food and Drug Administration recommends that microwave ovens not be used in home canning. It is believed that they do not produce or maintain temperatures high enough to kill harmful bacteria.

Observing these safety suggestions, as well as others that will be presented in subsequent chapters of this book, will help to minimize exposure levels and the risk of serious accidents.

—Our thanks to the publishers of *AWAKE!* Magazine. Much of the preceding information was adapted from the 3/22/81 (pp. 13-15), 4/22/81 (pp. 12-15), and 5/22/81 (pp. 27-28) issues of *AWAKE!*

3.7 MICROWAVES AND CARDIAC PACEMAKERS

It has been a subject of great concern, especially for many heart patients, that stray leakage from microwave ovens could interfere with the proper operation of their cardiac pacemakers. The fact is, there are at least 20 other known sources of electromagnetic interference that could also cause a pacemaker to malfunction if it were *non-shielded.* RF interference is generated by such common items as: electric shavers, auto ignition systems, walkie-talkie radios, fluorescent lights, and dial telephones. Many more of these electronic interference-emitting products are commonplace items even in hospitals; diathermy, electro-surgical units, electric bed motors, elevators, personnel pagers, electric heaters and heating pads, to mention a few.

The problem has been resolved, for the most part, with the development of a new *shielded*

pacemaker. Since microwaves, or any other type of electronic interference, cannot penetrate their stainless steel casing, the possibility of harm to people who wear these modern heart pacemakers is extremely remote. In an effort to determine the overall susceptibility of these units to electromagnetic interference, U.S. government agencies contacted all known U.S. manufacturers of cardiac pacemakers. Their findings indicate that less than 1% of all pacemakers are sensitive to electronic interference and this number is rapidly decreasing. Apparently, the *external demand* type of pacemaker continues to be a particularly sensitive device, so wearers of this type of pacemaker should avoid all possible sources of electronic interference. In fact, *all* patients with pacemakers would *be well advised* to contact the manufacturer of the unit *and* consult with their physicians for the final word on this matter.

While signs that warn "MICROWAVE IN USE" are not a federal requirement, local administrations or establishment owners may prefer to display such signs for various reasons. For example, some may display warning signs for their own protection (like a "watch your step" sign), to avoid the possible psychological trauma that could be suffered by an unwary pacemaker patient who suddenly discovers that he is sitting next to an operating microwave oven.

3.8 RADIATION INJURIES FROM MICROWAVE OVENS?

A 1986 report on microwave oven radiation by, among others, the Food and Drug Administration, has this to say: "There have been allegations of radiation injury from microwave ovens. The injuries known to FDA, however, have been injuries that could have happened with any oven or cooking surface. For example, people have been burned by hot food, spattering grease, or steam from food cooked in a microwave oven.

3.9 COLOR TELEVISION EMISSIONS

While not necessarily related to microwave safety, these types of emissions merit brief consideration because they are in the same family as microwaves, and are very often the subject of consumer concern.

Emissions from color TV sets are of the nature of X-rays, which are more serious and penetrating than low-level microwaves. However, modern circuitry improvements, combined with the stringent regulatory control of the Food and Drug Administration (FDA), have brought color TV emission levels to below that of certain natural background radiations. Just as there is a greater risk of excessive leakage from older, or improperly serviced, microwave ovens, so too, the same potential hazard exists with color television sets. In either case, it would be the course of wisdom to observe appropriate precautions. Use discretion when buying a used color TV set or microwave oven. Selection of a repairman should be done with scrutiny. And, sit or stand no closer to the unit than is necessary.

A Final Word

As with so many modern conveniences, the benefits must be weighed against the hazards, the risks against the rewards. Sometimes this can be a delicate and a controversial balance. So, while these devices must be used at one's own risk, the application of common sense and caution will certainly minimize the risk factor in this balance. A growing knowledge and understanding of electromagnetic radiation is producing a better perspective, enabling a more clear definition of just what the balance is in each case and allowing each person to draw his or her respective a conclusions accordingly. Meanwhile, the controversy, the debate, and the research continue.

And, *so* do the repairs...

BACK | HOME | ABOUT THIS CD-ROM | ABOUT THE AUTHOR

Copyright © 1989-2000 J. Carlton Gallawa . All Rights Reserved Worldwide

THE COMPLETE MICROWAVE OVEN SERVICE HANDBOOK: Operation, Maintenance, Troubleshooting and Repair

Copyright © 1989-2000 J. Carlton Gallawa . All Rights Reserved Worldwide

The High-Voltage System

Chapter Seven

7.1 INTRODUCTION

The purpose of the *high-voltage system* (Fig. 7-1) is to generate microwave energy. The heart of the microwave oven, it steps up AC line voltage to *high voltage*, changes the high AC voltage to an even higher DC voltage, and then converts the DC power to RF energy.

The nucleus of the high-voltage system is the MAGNETRON TUBE.

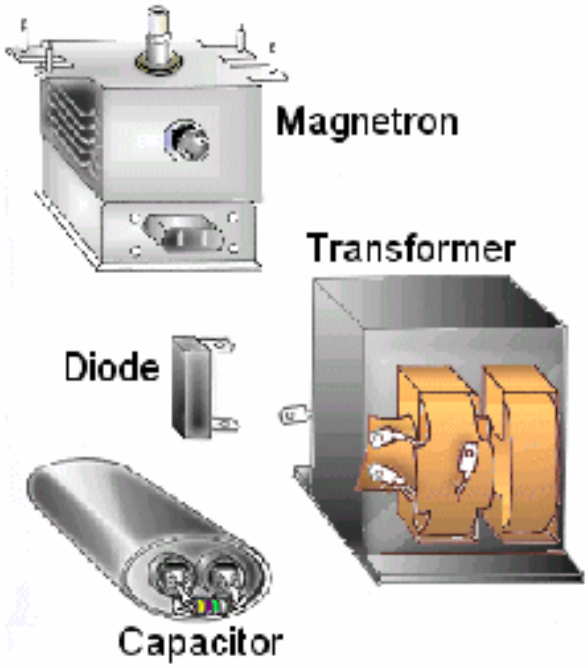


Figure 7-1 Typical high-voltage system. (Wagner / Gallawa)

7.2 MAGNETRON TUBE

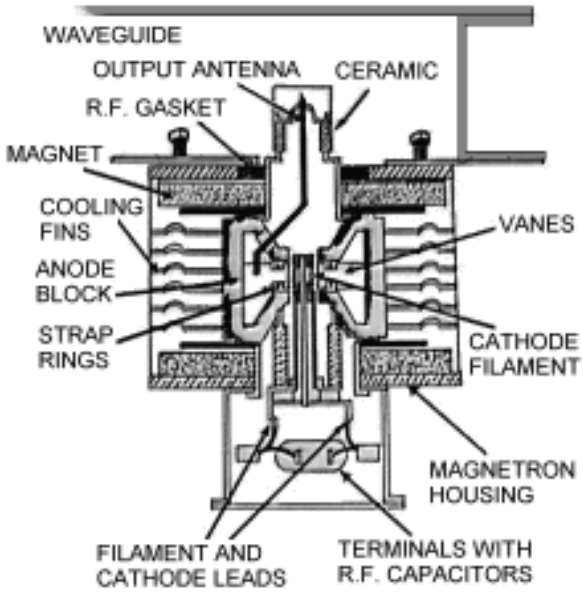


Figure 1 Sectional view of a typical magnetron (Courtesy of Michael S. Wagner)

The magnetron tube is a diode-type electron tube that is used to produce the required 2450 MHz of microwave energy. It is classed as a diode because it has no grid, as does an ordinary electron tube. A magnetic field imposed on the space between the *anode* (plate) and the *cathode* serves as the grid. Figure 7-2 is a sectional view of a typical magnetron tube. While the outer configurations of different type magnetrons will vary by make and model, the basic internal structures are the same. These are the *anode,* the *filament/cathode,* the *antenna* and the *magnets.*

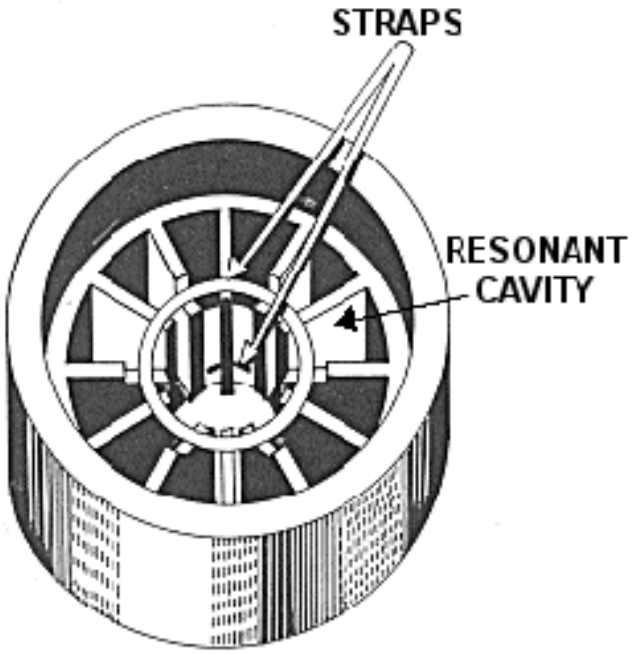


Figure 7-3 Typical anode vane block (Courtesy of Michael S. Wagner)

The ***ANODE*** (or plate) is a hollow cylinder of iron from which an even number of *anode vanes* extend inward, as shown in Figure 7-3 and Figure 7-3A. The open trapezoidal shaped areas between each of the vanes are *resonant cavities, which* serve as tuned circuits, and determine the output frequency of the tube. The anode operates in such a way that alternate segments must be connected, or strapped, so that each segment is opposite in polarity to the segment on either side. In effect, the cavities are connected in parallel with regard to the output. This will be become easier to understand as the description of operation is considered.

The ***FILAMENT*** (also referred to as the heater), which also serves as the ***CATHODE*** of the tube, is located in the center of the magnetron and is supported by the large and rigid filament leads which are carefully sealed into the tube and shielded.

The *ANTENNA*, a probe or loop connected to the anode and extending into one of the tuned cavities, is coupled to the waveguide into which it transmits the RF energy.

The other parts of the magnetron assembly may vary in their relative positions, size and shape, depending on the manufacturer. To keep the following explanation of operation as simple as possible, only the terms that are not self-explanatory as to their purpose will be

elaborated on.

The ***MAGNETIC FIELD*** is provided by strong permanent magnets, which are mounted around the magnetron so that the magnetic field is parallel with the axis of the cathode.

7.3 BASIC MAGNETRON OPERATION

The theory of magnetron operation is based on the motion of electrons under the combined influ- *(continued next page)*

BACK | HOME | ABOUT THIS BOOK | ABOUT THE AUTHOR | NEXT PAGE

Copyright © 1989-2000 J. Carlton Gallawa . All Rights Reserved Worldwide

Copyright © 1989-2000 J. Carlton Gallawa . All Rights Reserved Worldwide

Chapter Seven: The High-Voltage System (continued)

ence of electric and magnetic fields. For the tube to operate, *electrons* must flow from the cathode to the anode. There are two basic laws that govern this motion:

1. The force exerted by an electric field on an electron is proportional to the strength of the field. Electrons tend to move from a point of negative potential toward a positive potential.

Figure 7-4A (below) shows the uniform and direct movement of the electrons in an electric field, from the negative cathode to the positive anode, with no magnetic field present.

2. The force exerted on an electron in a magnetic field is at right angles to both the field itself, and to the path of the electron.

The direction of the force is such that the electron proceeds to the anode in a curve rather than a direct path.

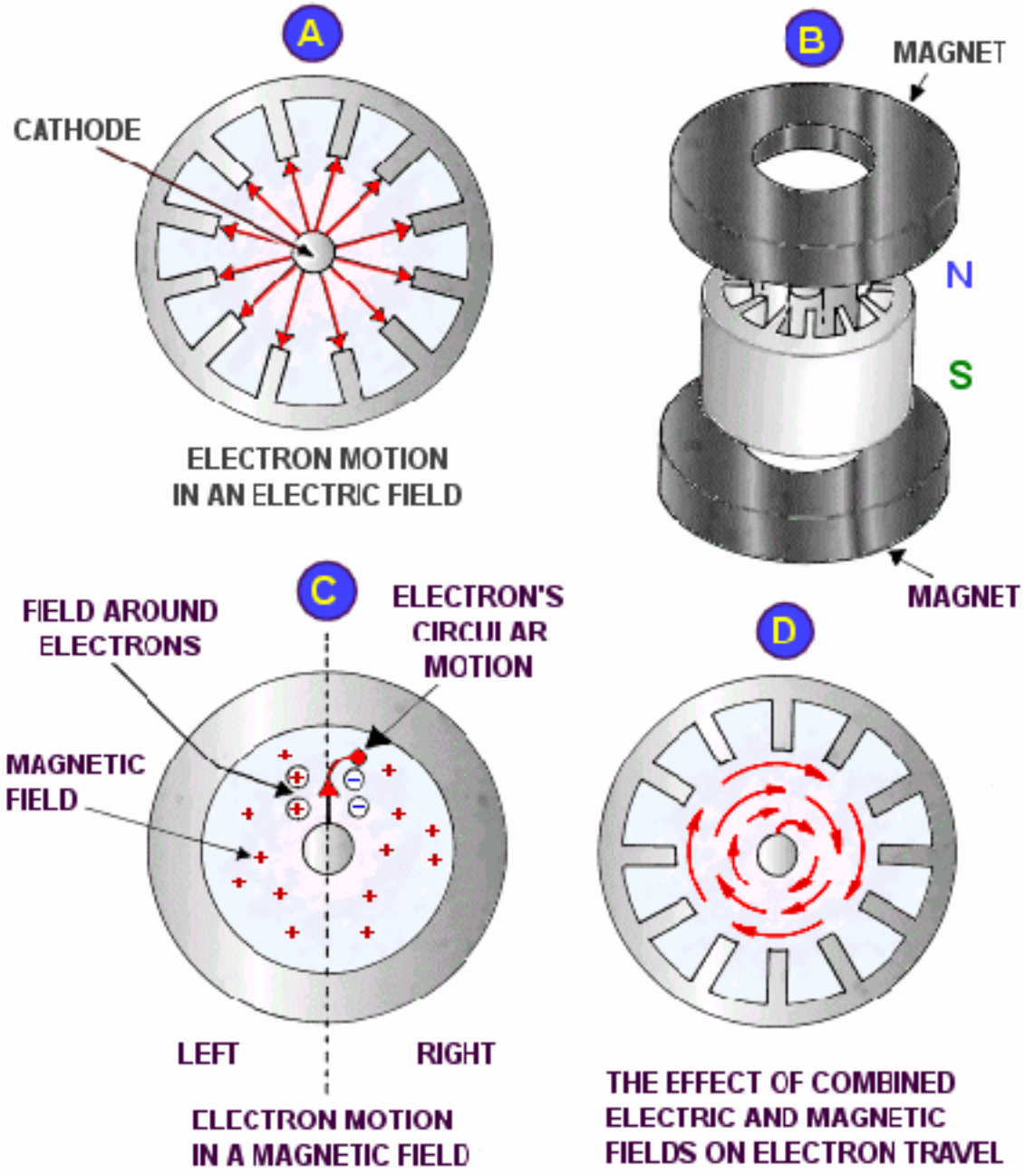


Figure 7-4 Electron motion in a magnetron tube. (Wagner / Gallawa)

7.3.1 Effect of the Magnetic Field

In Figure 7-4B two permanent magnets are added above and below the tube structure. In Figure 7-4C, assume the upper magnet is a North Pole and you are viewing from that position. The lower, South Pole magnet, is located underneath the Figure so that the magnetic field appears to be going right through the paper. Just as electrons flowing through a solid wire cause a magnetic field to build up around the wire, so an electron moving through space tends to build up a magnetic field around itself. On one side (left) of the electron's path, this self-induced magnetic field adds to the permanent magnetic field surrounding it. On the other side (right) of its path, it has the opposite effect of

subtracting from the permanent magnetic field. The magnetic field on the right side is therefore weakened, and the electron's trajectory bends in that direction, resulting in a circular motion of travel to the anode.

The process begins with a low voltage being applied to the filament which causes it to heat up *(filament voltage* is usually 3 to 4 VAC, depending on the make and model). Remember, in a magnetron, the filament is also the cathode. The temperature rise causes increased molecular activity within the cathode to the extent that it begins to "boil" off or emit electrons. Electrons leaving the surface of a heated filament wire might be compared to molecules that leave the surface of boiling water in the form of steam. The electrons, however, do not evaporate. They float just off the surface of the cathode, waiting for some momentum.

Electrons, being negative charges, are strongly repelled by like negative charges. So this floating cloud of electrons would be repelled away from a negatively charged cathode. The distance and velocity of their travel would increase with the intensity of the applied negative charge. *(Continued on next page)*

PREVIOUS PAGE | HOME | ABOUT THIS BOOK | ABOUT THE AUTHOR | NEXT PAGE

Copyright © 1989-2000 J. Carlton Gallawa . All Rights Reserved Worldwide

Chapter Seven: The High-Voltage System (continued)

The process begins with a low voltage being applied to the filament which causes it to heat up *(filament voltage* is usually 3 to 4 VAC, depending on the make and model). Remember, in a magnetron, the filament is also the cathode. The temperature rise causes increased molecular activity within the cathode to the extent that it begins to "boil" off or emit electrons. Electrons leaving the surface of a heated filament wire might be compared to molecules that leave the surface of boiling water in the form of steam. The electrons, however, do not evaporate. They float just off the surface of the cathode, waiting for some momentum.

Electrons, being negative charges, are strongly repelled by like negative charges. So this floating cloud of electrons would be repelled away from a negatively charged cathode. The distance and velocity of their travel would increase with the intensity of the applied negative charge. Momentum is thus provided by a negative 4000 volts DC, which is produced by means of the high-voltage transformer and the *doubler* action of the diode and capacitor. (4000 VDC is an average; the actual voltage varies with make and model.) A negative 4000-volt potential on the cathode puts a corresponding positive 4000-volt potential on the anode. Needless to say, the electrons leave the vicinity of the cathode with vigor, and accelerate straight toward the positive anode—But not for long.

As the electrons hasten toward their objective, they encounter the powerful magnetic field. The effect of the two permanent magnets, positioned so that their magnetic field is applied parallel to the cathode, tends to deflect the speeding electrons away from the anode as described earlier. Figure 7-4D (previous page) shows the effect of the magnetic field on the path of the electron. Instead of traveling straight to the anode, they curve to a path at almost right angles to their previous direction, resulting in an expanding circular orbit around the cathode that eventually reaches the anode.

PREVIOUS PAGE | HOME | ABOUT THIS BOOK | ABOUT THE AUTHOR | NEXT PAGE

Copyright © 1989-2000 J. Carlton Gallawa . All Rights Reserved Worldwide

Copyright © 1989-2000 J. Carlton Gallawa . All Rights Reserved Worldwide

Chapter Seven: The High-Voltage System (continued)

The whirling cloud of electrons, influenced by the high voltage and the strong magnetic field, form a rotating pattern that resembles spokes in a spinning wheel (Fig. 7-5). The interaction of this rotating space-charge wheel with the configuration of the surface of the anode produces an alternating current flow in the resonant cavities of the anode. This is explained as follows: as a "spoke" of electrons approaches an anode vane (or the segment between two cavities), it *induces* a positive charge in that segment. As the electrons pass, the positive charge diminishes in the first segment while another positive charge is being induced in the next segment.

Current is induced because the physical structure of the anode forms the equivalent of a series of high-Q *resonant inductive-capacitive (LC) circuits.* The effect of the strapping of alternate segments (mentioned earlier) is to connect the LC circuits in parallel (Fig. 7-6).

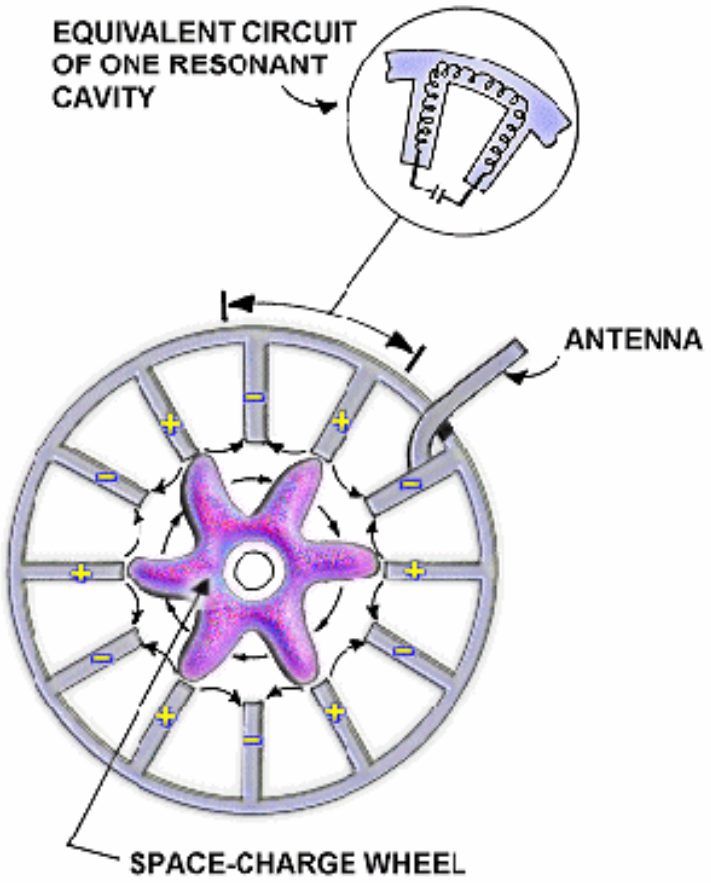


Figure 7-5 Electrons form a rotating pattern. (Wagner / Gallawa)

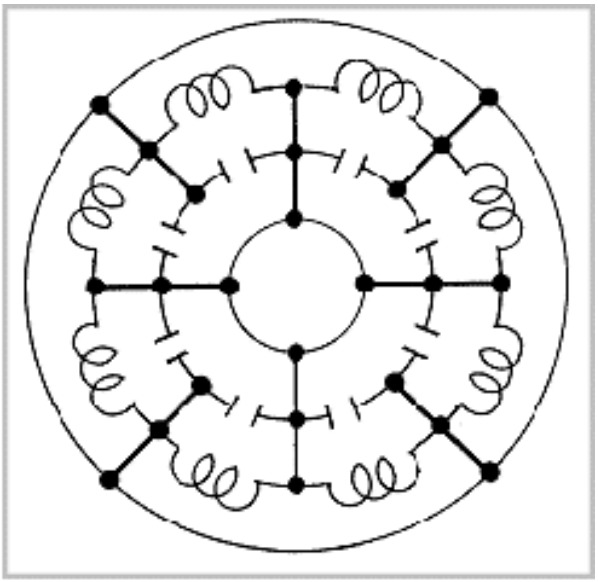


Figure 7-6 Equivalent circuit of cavities in parallel because of strapping. (Courtesy of Michael S. Wagner)

7.3.2 Resonant Circuits

A resonant circuit consists of a coil and capacitor connected in parallel and produces high-frequency current flow as next explained in Figure 7-7. In step 1, the battery (which represents the energy being supplied to the circuit by the passing "spoke" of electrons) will charge up capacitor Cl. In step 2, when S1 is switched to position "B" (which represents the electrons having passed by and therefore no longer inducing a charge) the capacitor discharges through coil L1. The current flow through the coil causes a magnetic field to develop around the coil, which is accompanied by an internally induced voltage of a polarity that opposes the capacitor discharge. In step 3, Cl has completely discharged and the energy is now stored in the magnetic field that surrounds the coil. In step 4, the magnetic field begins to collapse around the coil causing the voltage induced within it to change polarity. This tends to keep the current flowing in the original direction, which at step 5, charges the capacitor with a polarity opposite from its original charge. Consequently, at step 6 the capacitor again discharges through the coil, although in an opposite direction, starting the process all over.

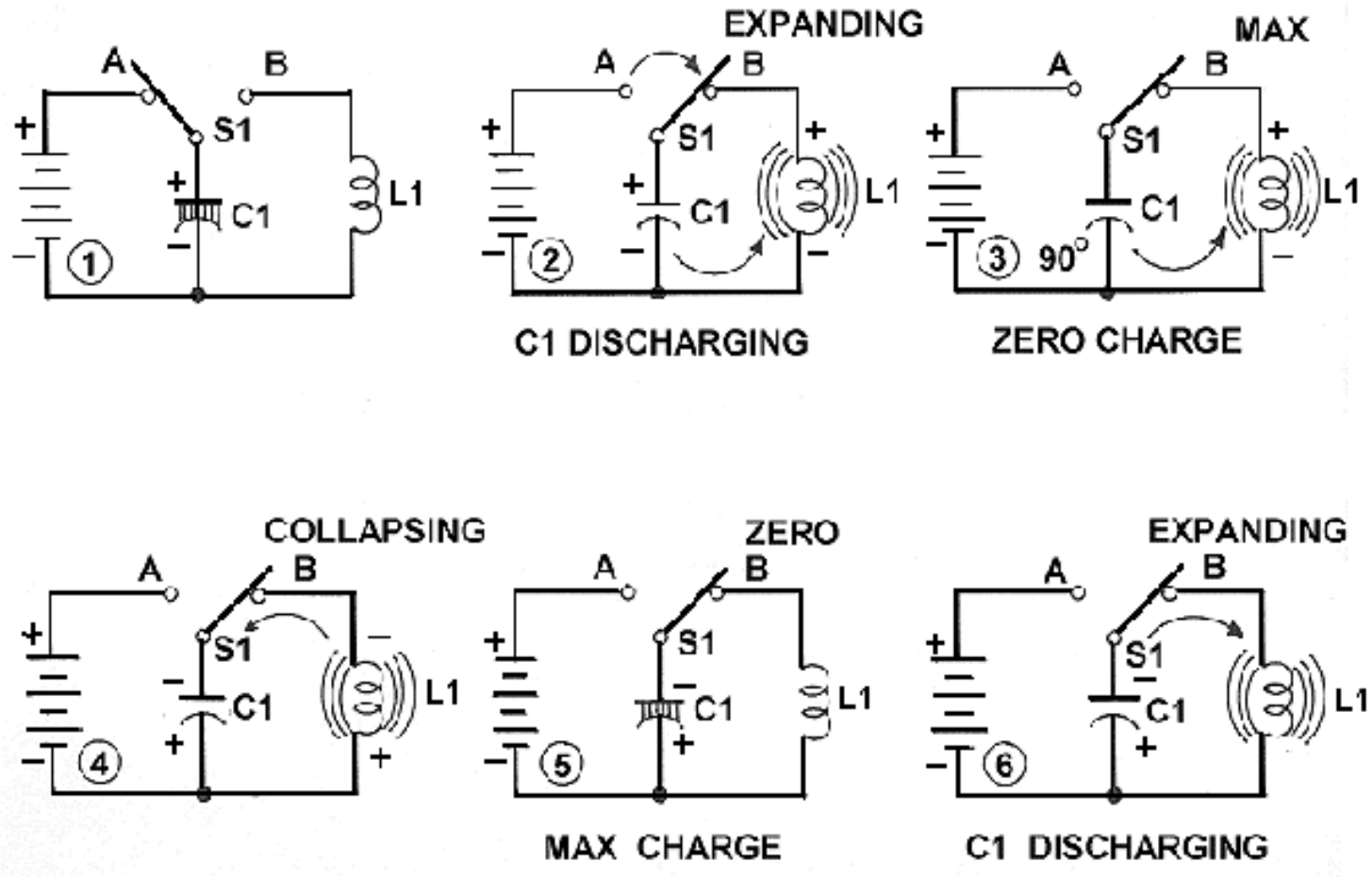


Figure 7-7 Basic operation of a resonant circuit
(Wagner / Dennis)

This seesaw action can produce extremely high oscillations, the frequencies of which are determined by the values of the capacitance and the inductance.

In each resonant cavity of a magnetron tube, the walls act as an inductor (or a coil), and the parallel sides of the opening form the plates of a capacitor (refer back to Fig. 7-5). Since the amount of inductance and capacitance is very small, the frequency of the alternating current is *(continued next page)*

PREVIOUS PAGE | HOME | ABOUT THIS BOOK | ABOUT THE AUTHOR | NEXT PAGE

Copyright © 1989-2000 J. Carlton Gallawa . All Rights Reserved Worldwide

Copyright © 1989-2000 J. Carlton Gallawa . All Rights Reserved Worldwide

Chapter Seven: The High-Voltage System (continued)

very high. The electromagnetic oscillations produced in the resonant cavities are intercepted by the antenna, which then couples the energy into a waveguide.

7.3.3 The Waveguide

Microwave energy cannot travel through a solid conductor, so the antenna radiates the RF power into a *waveguide.* The waveguide, a hollow metal tube (Fig. 7-8), transports the microwave energy into the oven cavity. Most microwave ovens use a rectangular shaped waveguide, through which the waves of energy travel by reflecting from side to side in a zigzag pattern.

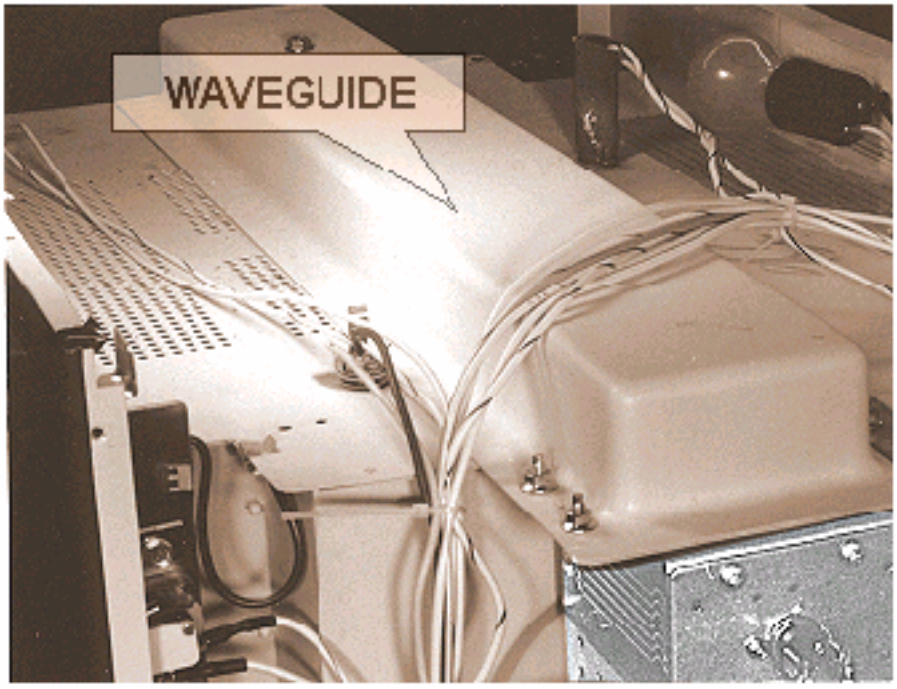


Figure 7-8 The waveguide is a hollow rectangular tube.

7.3.4 RF Capacitors

In order to prevent small amounts of RF current from backfeeding down the magnetron tube filament leads, which would cause excessive radio and television interference, *by-*

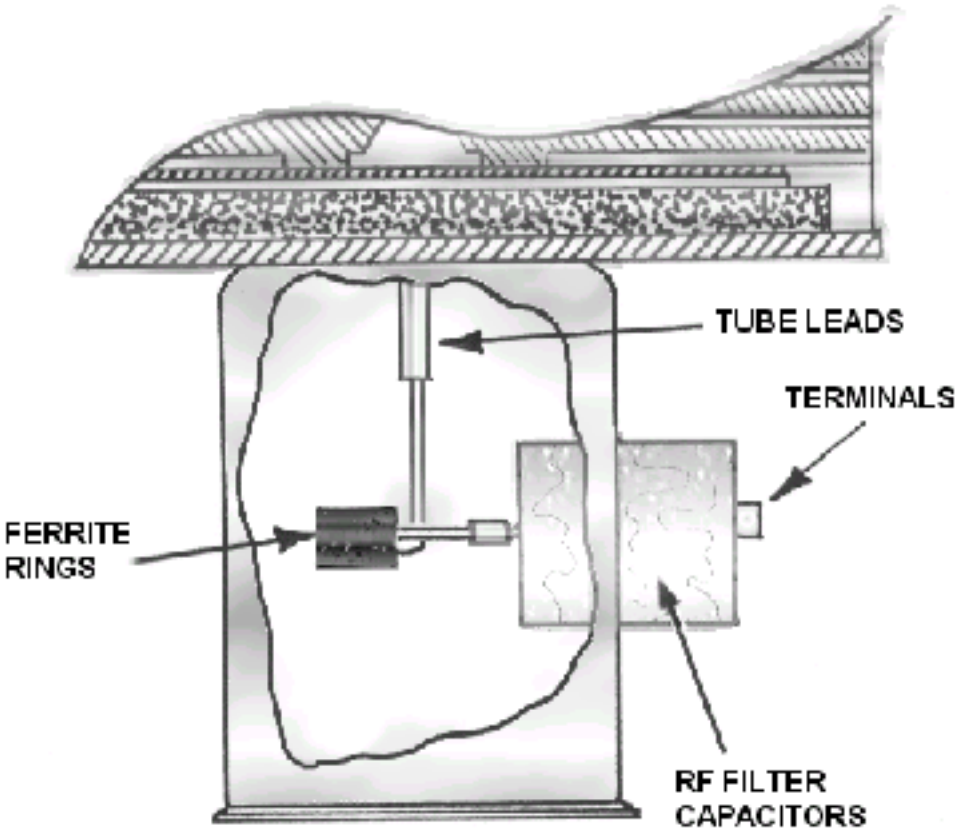


Figure 7-9 RF capacitors and ferrite rings in a magnetron tube (Wagner / Gallawa)

pass (or RF) *capacitors* and *ferrite rings* are added to the magnetron assembly (Fig. 7-9). By-pass capacitors filter off any backfeeding current to ground. The ferrite rings are magnetic and oppose high-frequency current flow.

7.3.5 Cooling Fins

Other features of the magnetron structure are the cooling fins, which dissipate the tremendous heat generated by an oscillating magnetron, usually maintaining an operating temperature of about a 260 deg. F (86 deg. C).

(continued on next page)

PREVIOUS PAGE | HOME | ABOUT THIS BOOK | ABOUT THE AUTHOR | NEXT PAGE

Copyright © 1989-2000 J. Carlton Gallawa . All Rights Reserved Worldwide

Copyright © 1989-2000 J. Carlton Gallawa . All Rights Reserved Worldwide

Chapter Seven: The High-Voltage System (continued)

7.3.6 Proper Phasing

Located near the filament terminals are the designations "F" and "FA" (Fig. 7-10). These insure that proper phasing is maintained when reconnecting the filament and high-voltage leads. Proper phase relationships, or polarities, within the high-voltage circuits are important. Failure to observe these relationships when reconnecting wires can put high-voltage components out of phase with each other. This can cause such symptoms as intermittent "popping," and even the premature failure of the components.

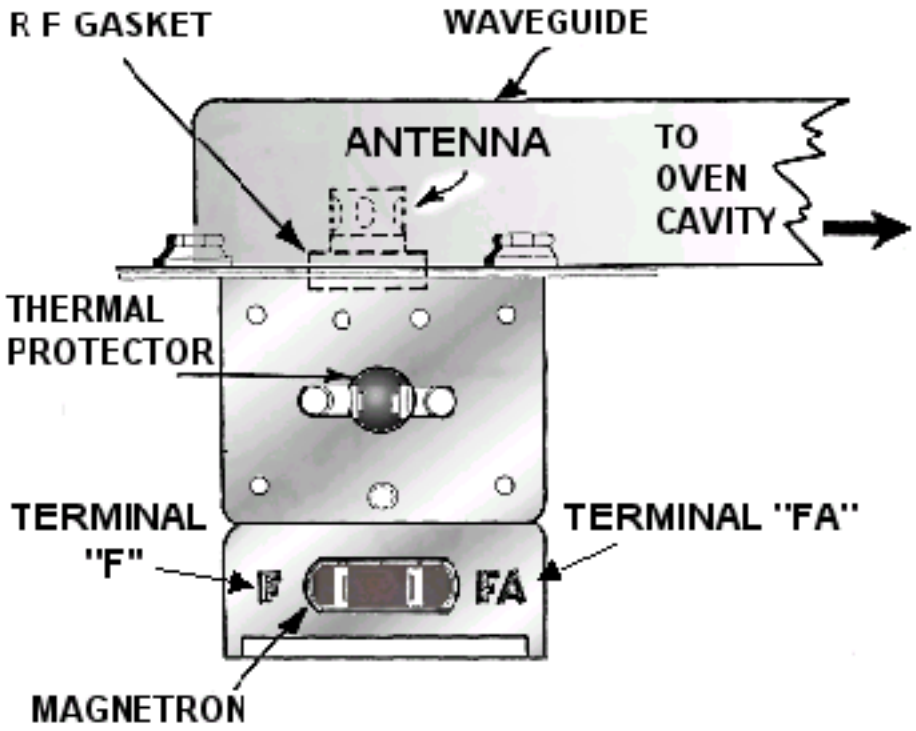


Figure 7-10 Magnetron terminal designations for proper phasing. (Wagner / Gallawa)

7.3.7 Magnetron Life Expectancy

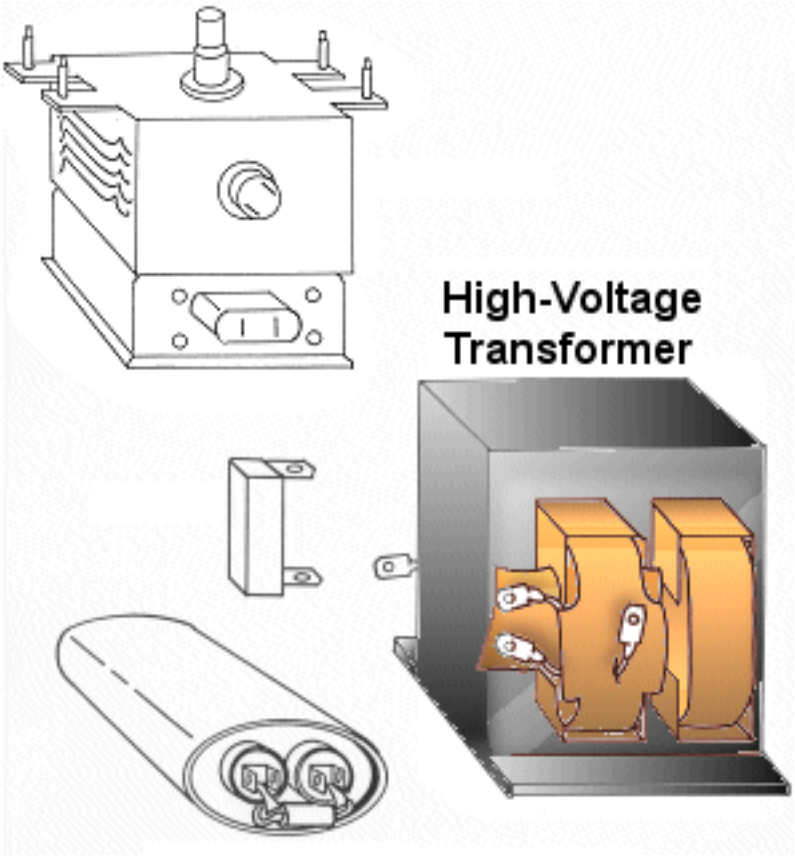
The typical life of a magnetron tube is approximately 2000 hours of operation. Some factors that can diminish the life of a magnetron are: 1) no-load operation, 2) operating with too much metal in the cooking cavity, 3) line voltage consistently too low or too high, 4) improper phasing, 5) improper installation or removal, 6) replacing associated high-voltage components with substitutes that are incompatible with the system design, 6)

continual operation at the upper limit of its heat tolerance due to inadequate air circulation, 7) obstruction in the wave-guide, 8) failed stirrer operation.

Coverage of magnetron failure modes, testing, and replacement procedures begins in *Section 12.4.*

7.4 TRANSFORMERS

In microwave oven circuits, transformers serve two functions: either they increase (step up) voltage, or they decrease (step down) voltage. The first type of transformer to be considered will be the *step-up* transformer.



7.4.1 High-Voltage Transformer — Fig. 7-11

The high-voltage transformer (also referred to as power or plate transformer) is of the step-up vari-ety. With a typical voltage of 120 VAC (± 10%) applied to the primary winding (some commercial units are designed to operate with a primary voltage of 208 to 240 VAC), the transformer will step the voltage up to approximately 2400 VAC at the sec-ondary output. Transformers work on a principle called mutual induction. It is the physical charac-teristics of the transformer combined with an input of alternating current that produces this process.

A simple step-up transformer consists of an open square or frame of iron called the core. Coils of insulated wire are wound around the two opposite sides of the core forming two separate coils. *(continued)*

PREVIOUS PAGE | HOME | ABOUT THIS BOOK | ABOUT THE AUTHOR

Copyright © 1989-2000 J. Carlton Gallawa . All Rights Reserved Worldwide

Exerpts from the CD-ROM:

THE COMPLETE MICROWAVE OVEN SERVICE HANDBOOK: Operation, Maintenance, Troubleshooting and Repair

Copyright © 1989-2000 J. Carlton Gallawa . All Rights Reserved Worldwide

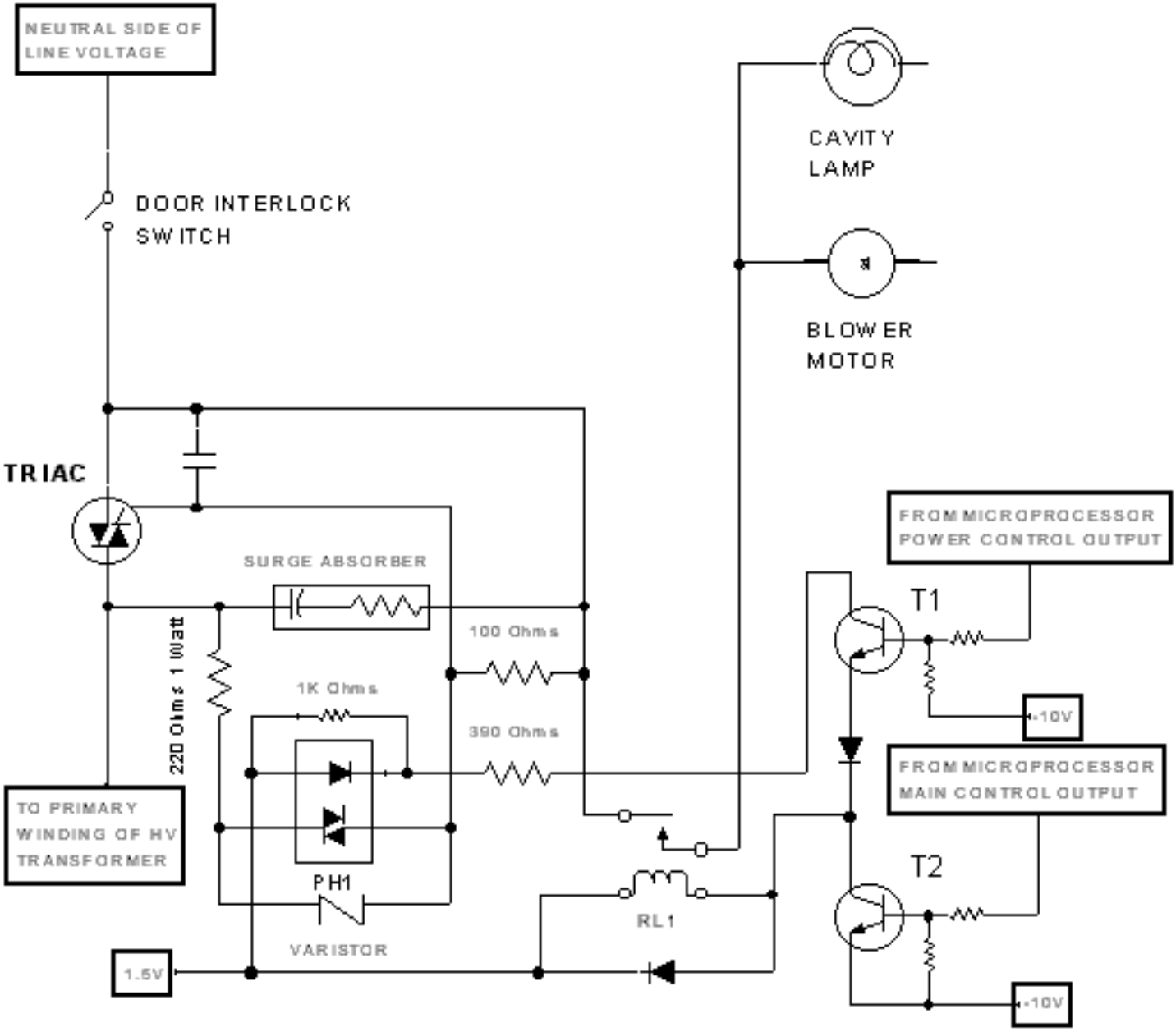
8.13.05 Triac Drive Circuit

The schematic below shows a typical triac drive circuit. As noted, the triac is an electronic switch (or solid state relay) that is capable of controlling heavy AC loads with a high duty cycle.

In a microwave oven, the magnetron is generally supplied by rectified high voltage obtained with a 50/60 Hz transformer. In models that use a triac, the voltage supplied to the magnetron power supply is controlled by the triac, which is in series with the primary winding of the transformer.

The description of operation is as follows. When the oven door is closed and a cook cycle is initiated, the main microprocessor sends a signal to transistor T1 causing the circuit to switch on. Next, at a synchronized time that depends on the model, optocoupler PH1 / IC1 (sometimes called photocoupler) activates and provides an output "gate" voltage that triggers the triac, switching it on and thereby providing a current path to the primary winding of the high-voltage transformer. The oven lamp, blower motor and stirrer motor (in some models) are controlled by relay RL1, which is driven by transistor T2.

Current flow through the optocoupler circuit is controlled by a 220-ohm 1-watt limiting resistor. To protect the circuit from inductive kickback when the load is switched off, a surge absorber (or snubber) is placed in parallel with triac main current carrying terminals. The varistor absorbs the potentially destructive energy of incoming transient pulses, thereby protecting vulnerable circuit components.



- (continued next page)

BACK | HOME | ABOUT THIS CD-ROM | ABOUT THE AUTHOR | NEXT PAGE

Copyright © 1989-2000 J. Carlton Gallawa . All Rights Reserved Worldwide

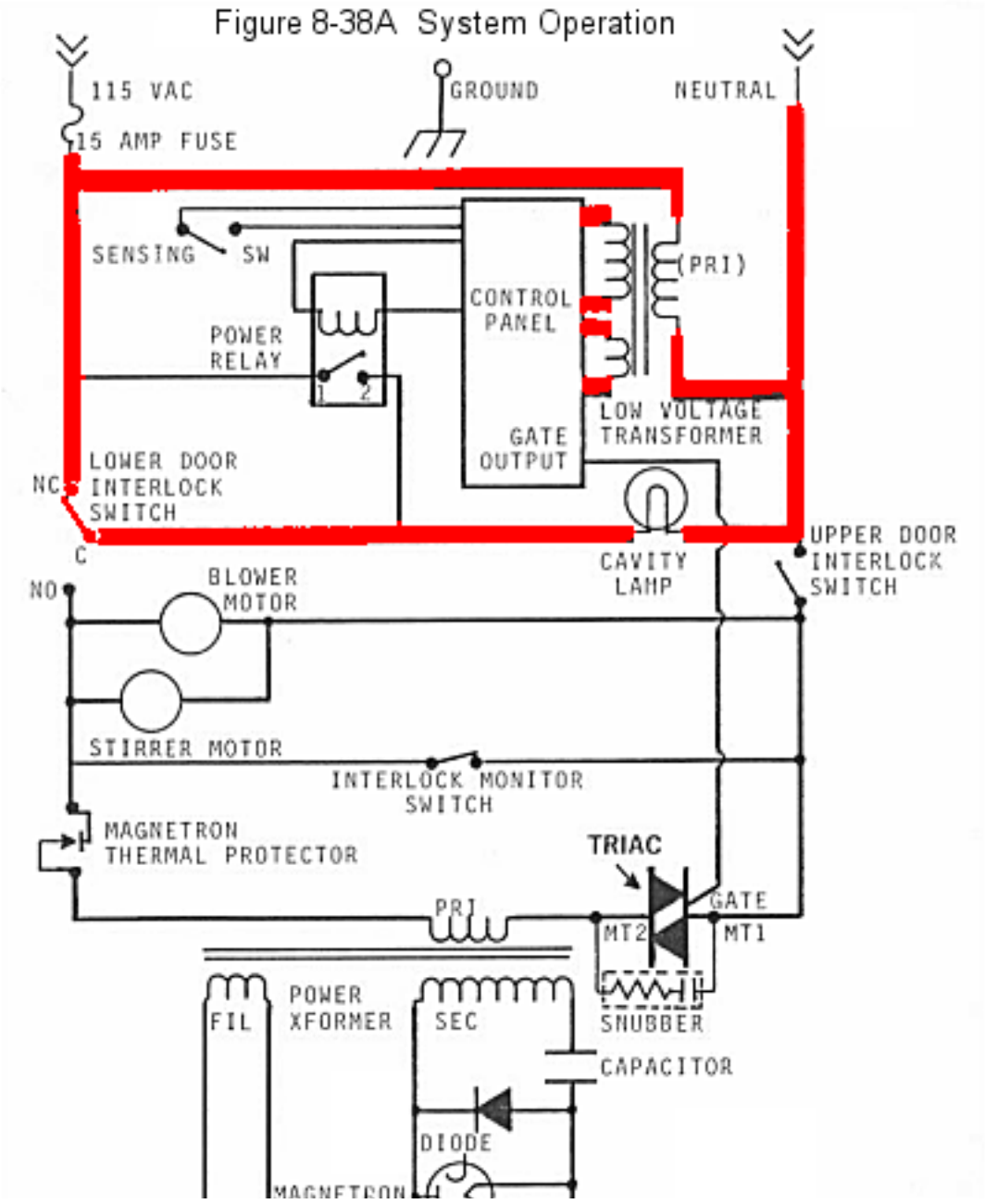
Copyright © 1989-2000 J. Carlton Gallawa . All Rights Reserved Worldwide

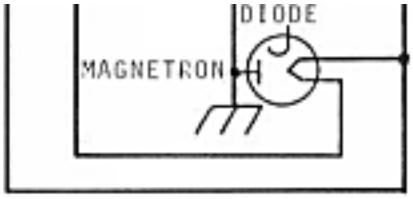
Chapter Eight: Control Systems (continued)

8.13.1 System Operation

The representative schematics of Figure 8-38 illustrate the typical operation of a triac-controlled system. Notice that the schematic symbol for a triac resembles the two SCRs connected in the antiparallel configuration shown earlier in Figure 8-34. A triac is essentially two silicone rectifiers fabricated in an antiparallel arrangement with a common gate. To gain a better

Figure 8-38A System Operation





understanding of an entire operating system, the explanation to follow is of a typical triac-controlled circuit in the context of a schematic that includes all the associated components necessary for an actual working system. Unfamiliar components that are not explained at this time will be elaborated upon in subsequent chapters. Refer to Figure 8-38.

SCHEMATIC #1

With the oven plugged into a standard 115 VAC grounded outlet, voltage is applied through the 15 amp FUSE to the primary of the LOW-VOLTAGE TRANSFORMER, which sup-plies the operating voltages to the control circuitry. The time-of-day clock operates and the CONTROL PANEL is ready to receive instructions.

The oven door is then opened and the CAVITY LIGHT illumi-nates with current supplied through the normally closed (NC) contacts of the LOWER DOOR INTERLOCK SWITCH

(Continued on next page)

PREVIOUS PAGE | HOME | ABOUT THIS BOOK | ABOUT THE AUTHOR | NEXT PAGE

BACK | HOME | ABOUT THIS CD-ROM | ABOUT THE AUTHOR

Exerpts from the CD-ROM:

THE COMPLETE MICROWAVE OVEN SERVICE HANDBOOK: Operation, Maintenance, Troubleshooting and Repair

Copyright © 1989-2000 J. Carlton Gallawa . All Rights Reserved Worldwide

(Excerpt)

13.3 SOLID STATE COMMERCIAL TIMERS

When symptoms indicate a possible problem in the timer there are but a few ways in which to test that likelihood. The symptoms themselves can give ample evidence of a defective control board. Whereas all of the following symptoms apply to electronic commercial-type timers, many of the indications are equally symptomatic of most domestic-type electronic control panels.

13.3.1 Symptoms That Can Denote a Defective Electronic Timer

SYMPTOM:

Any type of irregularities or inconsistencies in the display, such as: 1) missing, dimming, flashing, flickering (a slight fluorescent flicker is normal), or overly bright numbers or segments; or 2) the occasional appearance of illogical or mysterious Chinese-like characters (this may also be the result of improper or inadequate grounding).

SYMPTOM:

Any type of programming problems, for example: 1) Pressing one number or function and the panel responding with another; or, some pads program and others do not. These symptoms may be caused by either the touch panel or the control panel or both. When these panels are available separately, a determination of fault

must be made. ***Section 13.5.1*** and ***Appendix I*** will be of great assistance toward making a logical conclusion. 2) Limited or no programming functions. An exception to this symptom is the fact that some models made by *Sharp* will not program unless the *stop switch* is in the closed position. Therefore the oven door must be closed and the stop switch properly adjusted before the control panel will accept programming. 3) The control panel "locks up"; maybe one or more numbers will be displayed, but the panel will not reset or program.

SYMPTOM:

The control panel "kicking out" of a cook cycle prematurely, then possibly "locking up." The oven may have to be unplugged then plugged back in before the panel will accept programming. Possible causes: poor or improper grounding; or, excessive amounts of stray RF leakage, either from the latch side of the door, or from the magnetron within the component compartment. If removing the outer case alleviates the symptom, suspect leakage from the RF gasket or the internal structure of the magnetron.

SYMPTOM:

The control panel counts down too quickly or too slowly. Inaccurate timing *may* also be the result of an oven (of the type that can be converted from 50 to 60 cycles and vice-versa) being set for the wrong voltage or frequency for the area in which it is being used.

SYMPTOM:

The control panel will not start, or fails to count down when started; or, the panel counts down but neglects to activate the cook relay, triac, stirrer or blower motor, or other panel-controlled component. This may also be the result of a misadjusted or defective interlock switch, faulty wiring or related connections, or an open thermal protector or fuse.

NOTE: The triac or triac module (part of many control units) may be checked in several ways, all of which are outlined in ***Sections 13-12*** through ***13.16.***

SYMPTOM:

Either *all* indicator lights are lit, or no display at all, as though the panel is "dead." (In the case of no display or a "dead" panel, ensure that the low-voltage control transformer is supplying the appropriate voltages. Or if the low-voltage transformer is part of the control board, check for the appropriate input (primary) voltage to the panel before judging it to be defective.)

SYMPTOM:

Either a continuous beep or buzz; or none at all.

SYMPTOM:

The timer buttons remain depressed, thus holding the oven in a continuous cook mode. *Litton* and some other models use individual pushbuttons that are soldered on to the printed circuit board. These buttons may stick in the depressed position due to inadequate clearance through the cutouts in the timer faceplate. In these cases, the circuit board position may be adjusted to equally center the buttons in their openings, ensuring that the cutouts and buttons are free of grease and residue. In more extreme cases, the size of the hole can be increased by filing the sides of the obstructing cutouts with a small, fine file (the circuit board must be removed first). Then clean any metal filings from the casting and re-assemble the timer, making sure that the timer board is centered so that the buttons operate freely.

Self-Diagnosis: As digital circuitry becomes more sophisticated, more manufacturers are providing a self-diagnostic test sequence that can be programmed into the control unit. The control panel responds, in most cases, with a code that indicates the likely problem area. For the respective test and related codes for any of the various models that offer this feature, consult the appropriate service manual or contact the manufacturer.

13.4 DOMESTIC CONTROL CIRCUITS—CHECKS AND FAILURES

If new technology is reflected anywhere, it is in the control circuitry of the sophisticated microwave ovens designed for home use. It seems, paradoxically, that as technology advances, the field-availability of the corresponding technical data declines. Indeed, the service literature testing procedures for many control units amount to nothing more than programming instructions, although the value of these should not be minimized, because not knowing how to operate the oven you are about to repair can be quite perplexing to the anxious onlooker who owns the unit.

Isolating a fault in a domestic control panel is accomplished, for the most part, by observing symptoms, just as with the preceding commercial units. In fact, all of the symptoms, causes and corrections just listed for commercial control panels apply equally to their domestic counterparts.

The service literature supplied by many manufacturers provides input and output data for the respective control unit. In these cases, a fairly certain diagnosis can be made using that data. A few non-U.S. manufacturers provide detailed schematic information for their commercial and domestic control panels. In these cases, the servicer has the option of either attempting to repair the unit at the board level, or simply replacing the entire panel. Either way, the *option* is nice.

Many control panels are designed to supply the drive voltage for components such as the blower and stirrer motors, an external triac or relay, the transformer primary winding, and so forth. The panel's output in each case can be verified in the following manner: 1) Unplug the oven, remove the outer cover and **DISCHARGE THE HIGH-VOLTAGE CAPACITOR(S)**. 2) Attach a meter

(using insulated alligator clips) capable of the measuring the intended voltage to the input terminals of the component in question. (When no technical data is available, the appropriate drive voltage for a given component can usually be ascertained from the case of the component itself). 3) Operate the oven and observe the reading on the meter. 4) If the proper drive voltage for that component is shown, the panel is operating normally in that respect. 5) If an abnormal reading is obtained, either the panel or the wiring in between is at fault.

In conjunction with the preceding symptoms, some additional, rather uniquely domestic-type control panels symptoms are as follows:

SYMPTOM:

Glass touch panel lock up. The panel will not program or reset and possibly a row of numbers are displayed. Before replacing the control panel, *ensure* that the oven is properly grounded and polarized. Static discharge control panels in ovens manufactured by *Amana* and *Tappan* are particularly sensitive in this respect.

SYMPTOM:

Glass touch panel "starts," but immediately stops and either displays the time remaining, or reverts to displaying the time of day. Once again, suspect a grounding or polarization problem first—especially with a *Tappan-made* model.

SYMPTOM:

The time-of-day clock does not hold or keep the correct time.

SYMPTOM:

Temperature probe, sensor cook or other special features do not function properly. Do not assume the control panel is at fault, though, until the temperature probe, humidity sensor, or other related circuitry and wiring are checked. Also, tactfully determine if the operator is using the feature properly.

SYMPTOM:

The oven cooks constantly, regardless of the power level selected. Check the control panel's triac-drive output as described in ***Section 13.12.2***. If a constant voltage is measured when no cook operation has been initiated, or a constant voltage is shown during defrost and other low-power operations, the control panel is defective and must be replaced.

SYMPTOM:

The program erratically shifts or jumps to different functions or memories, or resets

itself by erasing the display—except possibly for the colon.

SYMPTOM:

If while counting down, the display jumps or skips time, suspect the panel if the grounding is proper and the polarity correct.

SYMPTOM:

The control module *(Amana)* appears to be "dead." Indeed, it may well be, but first check for an open *thermal fuse* on the magnetron or cavity, or both.

13.5 MYLAR (MEMBRANE) TOUCH PANEL OR THE CONTROL PANEL—WHICH?

For those who like games of chance, the process of determining whether programming problems are being caused by the control panel or the touch panel can be quite challenging—to your skill as well as your patience. Making the right choice becomes especially venturesome if the symptoms are intermittent; it becomes an educated guess with a *50-50* chance of being correct. However, for those who are not so inclined, the following symptoms, tests and visual indicators will help in separating the cause from the effect, thereby enabling the most logical deduction.

13.5.1 Membrane Touch Panel Evaluations and Considerations

Examine the ribbon cable for evidence of contaminants or "bleeding" between the lines on the ribbon. While a certain amount of tarnishing is normal and does not in itself mean the touch panel should be replaced, the appearance of black spots or fine web-like lines between the silver conductor traces *are* good signs that the touch panel should be replaced.

Inspect the area of the ribbon tail that slips into the board connector for cleanliness, for sections where the silver has worn off, or for evidence of scratching or hairline cracks. If cleaning is necessary, do so using an alcohol or freon-based contact cleaner. Do not use silicone-based cleaners or lubricants. Gently rubbing the terminals with a soft pencil eraser will also clean them, but, a word of caution: test the effect of the eraser on a non-essential area first! Erasers have been known to clean the silver right off of the ribbon. In many cases, the problem can be resolved simply by evenly trimming off about 1/16-inch from the tail of the ribbon, leaving fresh new terminals to assure good electrical contact with the circuit board connector.

A close examination of the front of the membrane touch panel may reveal dents or deep scratches that may be creating a short in certain touch pads. Also, brightening or dimming of the panel-display colons while pressing certain pads is a reasonably good indication that a signal is getting through to the control panel. In that case, try replacing control panel.

Some additional symptoms that indicate a defective key or touch panel are: 1) Only certain pads or groups of pads will respond while others will not. 2) Touching a pad produces a string of characters on the display. 3) One character remains constantly on the display, and disconnecting

the ribbon connector from the control board removes it. 4) Some or all pads must be pressed hard or pressed several times to produce a response. 5) The number displayed is different from the one pressed (i.e., press the "5" pad and a "9" appears on the display).

A categorized collection of *used touch panels* (or *keypads)* is a good idea for testing purposes. Unless they are totally inoperative, *do not throw away used touch panels.* They take up little room and can be used very effectively. For example, suppose you replace a touch panel because the "2" and "4" pads do not work. Label the defective panel appropriately, and save it. One day, a similar oven comes along, with a different symptom: the "start" pad will not respond. Temporarily replace the latter touch panel (with the unresponsive "start" pad) with the used touch panel having the functional "start" pad, and test the unit. If, with the substitute *test touch panel* installed, the oven still will not "start", the problem is likely not in the original touch panel. On the other hand, if the *test panel* "start" pad works, replace the original touch panel. A categorized collection of the touch panels—commercial and domestic—will take much of the gamble out of control panel-touch panel dilemma.

Besides the substitution of a known good panel, the next most certain method of isolating this type of problem is to make continuity checks through each of the touch unit circuits with an ohmmeter. However, without specific data on the matrix configuration of the unit to be tested, this is virtually impossible. Therefore, ***Appendix I*** contains many of the common matrix diagrams, listed by make and model number, and instructions on how they are tested.

An alternate method of checking touch panels when no matrix diagram is available is performed as follows: 1) Unplug the oven, remove the cover and **DISCHARGE THE HIGH-VOLTAGE CAPACITOR(S).** 2) Disconnect one or both leads from the primary side of the high-voltage transformer so no high voltage will be generated during the test. 3) Remove the flex-tail ribbon from the control board connector.

WARNING: HIGH VOLTAGES WITH HIGH CURRENT
CAPABILITIES ARE PRESENT DURING OPERATIONAL TESTS.
USE EXTREME CAUTION. DO NOT TOUCH COMPONENTS OR
WIRING WHILE THE UNIT IS PLUGGED IN OR OPERATING.

USE EXTREME CAUTION WHEN WORKING AROUND "LIVE" CIRCUITS.

4) Plug in the oven and, cautiously, use a jumper to make *momentary* contact between random points on the control unit connector. This, in many cases, simulates the touch pad (key unit) contacts. 5) If the control panel appears to respond in a relatively normal way, the touch panel is likely the problem. However, assuming this test is compatible with the unit under test, a control panel that fails to respond is probably defective. NOTE: For lack of access, some models may require that the control assembly be removed and placed beside the oven with all harness connections joined.

Many replacement touch panels are shipped with a protective plastic film. If the face of the panel

has a bubbled or a hazy appearance, it is probably due to this transparent film. Be sure to remove the plastic film before installing the touch panel.

BACK | HOME | ABOUT THIS CD-ROM | ABOUT THE AUTHOR

Samples from the *Master Microwave Oven Repair Guide*

Copyright © 1998-2000 by John C. Gallawa. All rights reserved worldwide.

AMANA

Models: DQ22HS, RC22, RC22S, RC22MP, RC22MPS, MC22MP, MC22MPT (Commercial models)

Symptom: Display shows **PCE6**

Problem: This is what Amana refers to as a "communcations failure" and could be caused by any of the following:

1. Broken or improper wire connection between high voltage board and low voltage board.
2. Inoperative cable between low voltage board and extended memory board.
3. Inoperative high voltage board
4. Inoperative low voltage board
5. Inoperative extended memory board

Solution: Carefully check for broken, loose or misplaced wires. Repair as necessary. At present there is no practical way to isolate a defective circuit board other than replacing it.

KENMORE (Sears)

Model: 564.8878430

Symptom: Electrical burning smell during cook.

Problem: Shorted magnetron tube.

Solution: Replace magnetron tube.

PANASONIC

Model: NN-6371WM

Symptom: Stopped working after lightning storm

Problem: Built-in surge protection on printed circuit board has opened. This circuit consists of a fine foil pattern (or filter coil - depending on the model) that acts to fuse the primary side of the low-voltage transformer.

Solution: Rebuild the surge protection circuit. Replace the varistor

PANASONIC

Model: NE-8021, NE-8051, NN-4208A, NN-5407, NN-5500A, NN-5512A, NN-6370WM, NN-6371WM.N, NN-6372AWM, NN-6381A, NN-6482A, NN-6503A, NN-7524AK
Symptom: No heat, weak heat, or intermittent heat
Problem: Magnetron filament connectors have loosened and, due to resistive heat, the terminal connections have deteriorated and burned off.
Solution: Repair defective terminals as follows:Either (1) Cut away burned wire, clean the magnetron terminals, and replace the slip-on connectors, or (2) Cut away burned wire and connector(s). Clean terminals to prepare for soldering. Solder filament leads directly to magnetron terminals. Be careful not to apply soldering heat any longer than necessary

SHARP

Models: R-22DP, R-4A53, R-4A54, R-4A73, R-4A83, R3A53, R-4A93, R-4H80, R-5A98, R-7A82, R-7A85, R-8010
Symptom: Oven went dead, perhaps in the middle of cooking, and possibly accompanied by a faint electrical burning smell.
Problem: Weakened fuse clips in the fuse receptacle causing fuse to melt due to resistive heat. Usually indicated by a bead of solder leaching out from either endcap and/or evidence of overheating (or burned spot) at the endcap, fuse clip, or terminal connection
Solution: Replace 15 amp fuse (about $1.00) and receptacle (about $2.00) Note:In many cases, the fuse comes as a kit that includes an interlock switch. The Sharp part # FFS-BA015. Price:about $9.00
Additional Info: Generic fuses and fuse holders are available at appliance and electronic part suppliers.

SHARP

Model: R-8310
Symptom: Convection heat is too hot-burning things.
Problem: Opened thermistor
Solution: Replace thermistor. Sharp part # FH-HZ0017WRKO. Price:about $39.95

SHARP

Model: R-3A75, R-4A84, R-4K52, R-5A50, R-5A82, R-5A84, R-5F80, R-5K81, R-4260, R-4840, R-5560, R-5565, R-9200, R-9350, R-9480
Symptom: Arcing in cooking the compartment
Problem: Bits of food or other cooking debris has lodged beneath the waveguide cover (or stirrer cover, depending on the model). After repeated exposure to microwave energy, the cooking residue breaks down into carbon (which a conductor) and arcing occurs. This results in a burned spot in the waveguide cover.
Solution: Clean out all residual grease and cooking debris. Remove all traces of the blackened residue (carbon) from in and around the waveguide opening (use a light grade of sandpaper if necessary, but never use steel wool),. Finally, replace the waveguide cover. Price:about $5.00 - $7.00

TAPPAN

Model: 56-4675-10/02, 56-4677-10, 56-4804/06, 56-4884-10, 56-5897/01
Symptom: Fan comes on but the oven doesn't heat.
Problem: Cracked solder joints on printed circuit board.
Solution: Remove printed circuit board and examine it for cracked, burned, or deteriorated solder connections. In particular, check the solder joints where the harness connector is mounted. Clean, reinforce, and re-solder as necessary.

WHIRLPOOL

Model: MW8500XR, MW8520XP, MW8550XL, MW8650XR, MW8650XS, MW8750XP
Symptom: Weak or uneven heat
Problem: Broken stirrer belt
Solution: Replace stirrer belt. Part # 311958 Price:$5.00

Plus myriads more...

MICROTECH

Welcome to Microtech's

(Updated 1/2002)

© 1989-2002 J. Carlton Gallawa

A Free, On-Line Case History Database of Commercial and Residential Microwave Oven Repairs: Symptoms, Problems and Solutions

Important Safety Information for Repairing Microwave Ovens

Repairing a microwave oven is a dangerous task. For your personal safety, we respectfully ask that you read and understand these very **IMPORTANT SAFETY PRECAUTIONS** as well as the disclaimer at the bottom of this page BEFORE proceeding with any tests or troubleshooting.

Microwave Oven Repair Instructions

1. After reading the **safety precautions** and progressing here to the Microwave Oven **Fix Finder** repair database, select the alphabetical category below that corresponds to the ***brand*** of microwave oven you want to repair.
2. Find the ***model number*** , or the number closest to the model you are repairing.
3. Find the ***symptom(s)*** that most closely match the symptom(s) being displayed by the microwave oven you are repairing.
    - Generally speaking, many symptoms will apply to most models within the same brand category.
4. Follow the specific troubleshooting and/or repair instructions to complete the repair. Click on highlighted text for a detailed explanation of that procedure.
5. Since this database is constantly being updated and appended, if you don't find what you are looking for, try again at a later time.
6.

Click here **if you would like to be notified by e-mail when this page is updated.**

We hope that you find the information here helpful...

Common Sense Troubleshooting of Microwave Ovens

Effective troubleshooting begins with a systematic approach. The objective is to eliminate the cause, not just the symptom. Therefore, the way to a successful repair is guided by mindful alertness and common sense. Here are three basic guidelines:

1. **Be observant and alert to the obvious.** The majority of common problems that occur in microwave ovens are conspicuous and readily detectable by one or more of the senses -- your ears, eyes, or nose. For example, ***listen*** for abnormal, unusual sounds -- or the lack of a sound, such as the normal click of a microswitch. ***Look*** for the obvious:loose or burned connections, disconnected wires, broken binding or melted parts. And don't overlook the presence of any unusual odors. Many times the problem is staring you right in the face.
2. **Keep an open mind.** Keep in mind the areas where a particular trouble can *potentially* exist, but don't allow preconceived or indeterminate conclusions to blind you to the real problem. Ask yourself :'what could and could not cause this symptom?' Successful troubleshooting involves a process of logical deductions based on reasonable likelihood, then progressively eliminating all the least likely components until only the most probable suspects remain.
3. **Use your volt-ohm meter.** For a final and positive diagnosis, use your volt-ohm meter to make systematic continuity and resistance tests.

Experience has shown that, by means of authentic repair histories, most common problems can be quickly recognized and isolated by simply associating the symptom with the model or brand. Then, with careful observation and/or continuity tests, the problem can easily be diagnosed and solved.

Please make sure that you understand and are prepared to carefully follow the appropriate microwave oven repair safety precautions

Select the alphabetical category that corresponds to the brand you are repairing.

- The manufacturers' part numbers and prices listed here are subject to change without notice.
- The various models numbers are not necessarily in numerical order.

Disclaimer: *The author assumes no liability for any incidental, consequential or other liability from the use of this information. All risks and damages, incidental or otherwise, arising from the use or misuse of the information contained herein are entirely the responsibility of the user. Although careful precaution has been taken in the preparation of this material, we assume no responsibility for omissions or errors.*

Do good work.
Be careful.
Have success.

© 1989-2002 J. Carlton Gallawa .
All Rights Reserved Worldwide

Search our Site:
GO
sitemap

A to J | K to 0 | P to Q | R to Z | Home Page | Safety Information | Back | CD-ROM | Links | FAQ |

Microwave Oven Parts Suppliers & Manufacturer Contacts

You can contact these microwave oven parts suppliers and equipment manufacturers directly for replacement parts, product literature, dealer locations, technical assistance, etc. Please e-mail additions or corrections to: j.gallawa@cox.net

CLICK HERE

- **If you would like to learn more about repairing commercial, industrial and residential microwave ovens and become part of a multi-million dollar service industry, we invite you to take a look at Microtech's highly acclaimed CD-ROM.**
- **Take the finest repair video ever produced, combine it with the ultimate textbook on microwave oven repair, meticulously update every part and you have *"THE COMPLETE MICROWAVE OVEN SERVICE HANDBOOK v. 2002 on CD-ROM."* This is THE definitive step-by-step instructional CD to making safe, successful and profitable repairs on all types of microwave ovens.**
- **From the common tools you'll need and clearly outlined safety procedures, right down to the final profit-producing repair. This state-of-the-art courseware gives you the training you need in a progressive, straight-foward and easy-to-use format that's guaranteed to take you to the skill--and income--level you want.**
- **It takes every page of this 400-page, fact-crammed course to teach you all you need to know about this profitable field of repair.**

© 1989-2002 J. Carlton Gallawa . All Rights Reserved Worldwide

As of 1/8/98, you are visitor number 164010

Microtech

© 1998-2002 J. Carlton Gallawa
All Rights Reserved Worldwide

Last updated 1/2002

This page includes the brands:

Admiral to JCPenney

Page 1

Instructions on How To Diagnose and Repair Microwave Ovens

1. After reading the safety precautions , find the brand and model number, or the number closest to the model you are repairing.
2. Find the symptom(s) that most closely match the symptom(s) being displayed by the oven you are repairing.
3. Follow the specific troubleshooting and/or repair instructions to complete the repair. Click on highlighted text for a detailed explanation of that procedure.
4. Since this database is constantly being updated and appended, if you don't find what your looking for, try again at a later time.
5.

Click here

if you would like to be notified by e-mail when this page is updated.

Please Note:

- The manufacturers' part numbers and prices listed here are subject to change without notice.
- The individual model numbers are not necessarily arranged in numerical order

We hope that you find the information here helpful. . .

Important Safety Information

Repairing a microwave oven is a dangerous task. For your personal safety, please do not proceed unless you fully understand and are prepared to follow carefully these appropriate **safety precautions .**

Disclaimer: *The author assumes no liability for any incidental, consequential or other liability from the use of this information. All risks and damages, incidental or otherwise, arising from the use or misuse of the information contained herein are entirely the responsibility of the user. Although careful precaution has been*

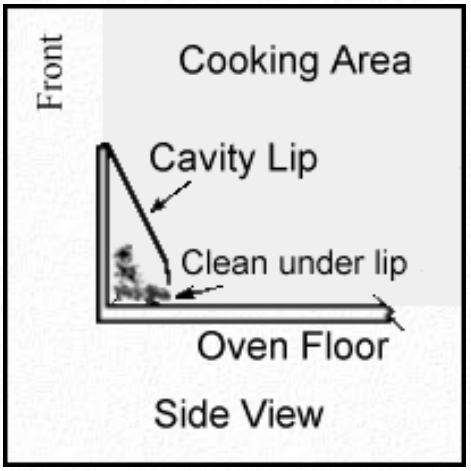
taken in the preparation of this material, we assume no responsibility for omissions or errors.

© 1996-2002 J. Carlton Gallawa
All Rights Reserved Worldwide
© Copyright Information

Do good work.
Be careful.
Have success.

MICROWAVE OVEN REPAIR CASE HISTORY DATABASE

AMANA



Model: M84T
Symptom: Arcing in cooking area.
Problem: Accumulation of food and cooking debris beneath front cavity lip.
Solution: Thoroughly clean all debris and carbon build up from under cavity lip (use a tool such as a plastic knife to penetrate underneath the lip opening and clear out all burned-on debris. Then use light sand paper to sand away any carbon build up. Finally, install a cavity lip protector, Amana part # R0803571. Price: about $8.00

AMANA

Model: MC2000MPP
Symptom: (1) Door hanging down. (2) Inner door molding cracked (3) Will not go into cook mode
Problem(s): (1) Door hinges (bushings) have worn prematurely, causing the (2) plastic inner door to strike the metal cavity wall when closing the door, and (3) producing a severe misalignment of the door latch mechanism.
Solution(s): (1) Install a hinge upgrade kit, Amana part # R0156889. Price: about $18.00 (2) Replace inner door assembly, Amana part # D7143803. Price: about $60.00 (3) Adjust primary interlock switch for proper actuation.

AMANA

Model: RC14S
Symptom: Certain pads will not respond.
Problem: Defective touch panel (switch panel).
Solution: Replace touch panel, Amana part # D7577807

AMANA

Model: RC14SE
Manufacturing Number: P7688114M
Symptom: Smoking and burning odor during cook. Weak heat.
Problem: Although this appears to be a simple case of a shorted high voltage transformer, there is actually a culprit that might be quite unanticipated: A shorted high voltage capacitor, which is causing excessive current flow through the windings of the high voltage transformer, thereby causing the

transformer to overheat and smoke.
Test: High Voltage Capacitor Test Procedure
Solution: Replace high voltage capacitor, Amana part # D85479-20. Price: about $11.00. If the high voltage transformer is damaged, it too must be replaced. Part # R0114320, list price: $77.38. The line fuse may also have be weakened, so it too should be replaced. Amana part # M0805201. Price: $4.50

AMANA

Model: RMC720
Symptom: Electrical burning smell and no heat
Problem: Burned connection on upper interlock switch
Test: Interlock Switch Test
Solution: Replace interlock switch, part # R0852501. Price: $7.00. Repair burned connector(s) by either (1) replace burned slip-on connector(s), or (2) cut off burned connectors and solder the harness wires directly to the appropriate switch terminals.

AMANA

Model: RR-700
Symptom: In cook mode, oven only counts down--no blower, no heat
Problem: Control relay (24 VDC) not being energized due to defective relay-drive circuit on main control board
Test: Test the relay itself as follows: Observe important safety precautions . Remove harness wires from control relay coil terminals and test for a normal resistance of about 500 to 900 ohms.
Solution: Remove main control panel. Determine relay drive circuit components by tracing relay coil wires back to the circuit board. Test all relevant transistors. Replace defective transistor(s).

AMANA

Model: MC22MP
Symptom: Will not program
Problem: Extended memory board is defective
Test: Observe the horizontal dashes on the display. If the fifth dash to the right is above the rest, the extended memory board is normal. If the fifth dash is even with, or below the rest, the extended memory board is defective.
Solution: Replace the extended memory board, Amana part # 10936806. List price: $179.

AMANA

Model: M84TMA
Symptom: Oven will not "start"
Problem: Broken door latch
Solution: disassemble door and replace broken door latch (or door key). Amana part # R0805592 upper door key; R0805593 lower door key Price: about $0.58 each

AMANA

Model: RMC20CET6
Symptom: Blows the fuse and goes dead about 30 seconds after start of cook cycle.

Problem: Shorted high voltage transformer.
Test: High Voltage Transformer Test
Solution: Replace transformer. Amana part #.D7474103. Price: $143.53

AMANA

Model: RCS 720A
Symptom: Door must be pushed or jiggled before oven will cook.
Problem: Defective switch module.
Solution: Replace switch module, part # R0163218. Price: about $28.00

BETTY. CROCKER

Model: BC-1861
Symptom: Pressed "Start" and the clicked then went dead.
Problem: In-line fuse not secured in fuse holder.
Solution: Replace fuse and insure that it is securely inserted into holder. Fuse: $1.50

EMERSON

Model: AR501
Symptom: Popped and went dead during cook cycle
Problem: Shorted high voltage capacitor
Test: High voltage capacitor test procedure
Solution: Install new fuse, part # M0S0063; price, about $1.50. Replace HV capacitor (.65Mfd, 2000VAC), part # M0S0060. Price: about $17.00 wholesale.

EMERSON

Model: M3060
Symptom: Dead
Problem: Weakened fuse clips in the fuse receptacle causing fuse to melt due to resistive heat. Usually indicated by a bead of solder leaching out from either endcap and/or evidence of overheating (or burned spot) at the endcap, fuse clip, or terminal connection
Solution: Replace 15 amp fuse (about $1.00) and receptacle (about $2.00)
Additional Inf: Generic fuse holders are available at appliance and electronic part suppliers.

FRIGIDAIRE

Model: MC-900M-2
Symptom: Went dead during cook
Problem: Weakened fuse clips on fuse receptacle causing fuse to melt due to resistive heat. Usually indicated by a bead of solder leaching out from either endcap and/or evidence of overheating (burned spot) at the terminal connection
Solution: Replace 15 amp fuse (about $1.00) and receptacle (about $2.00).
Additional Inf: Generic fuse holders are available at appliance and electronic part suppliers.

FRIGIDAIRE
Model: RCM10J

Symptom: Heats unevenly
Problem: (1) After a period of years, the center of the grease shield begins to sag. This diminishes the air-swirling action that is required to rotate the antenna [which functions to evenly distribute the microwave energy]. (2) The foam-type air gasket material is deteriorated or missing. This gasket serves to channel air from the blower assembly into the antenna chamber where the air flow drives the rotating antenna..
Solution: (1) Replace grease shield, *Amana* part # D7544002, price about $19.00; and install new air gasket material. See Amana Air Gasket Replacement Procedure.

FRIGIDAIRE

Model: MC1355L-5
Symptom: Sparked out the back of the microwave.
Problem: Buildup of food debris causing high voltage arc-over from high voltage capacitor terminal to chassis ground.
Solution: Clean away debris, repair burned connections and dress high voltage wires away from metal edges.

To Page 2 (A to J)

A to J | K to 0 | P to Q | R to Z | Home Page | Safety Info | Back | CD-ROM

Parts Suppliers and Manufacturer Contacts

You can contact these parts suppliers and microwave oven equipment manufacturers directly for replacement parts, product literature, dealer locations, technical assistance, etc. Please e-mail additions or corrections to: j.gallawa@cox.net

Glossary of Electronic and Microwave Oven Related Terms

Let us know what you think, or submit your own repair tip j.gallawa@cox.net

If you would like to learn more about repairing microwave ovens and become part of a multi-million dollar service industry, we invite you to take a look at Microtech's powerful new CD-ROM. You'll discover a virtual goldmine of trade secrets and have practical, illustrated step-by-step instructions on troubleshooting and servicing every microwave oven component.

THE COMPLETE MICROWAVE OVEN SERVICE HANDBOOK 2000
Operation, Maintenance, Troubleshooting and Repair
J. Carlton Gallawa

CLICK free! SAMPLES

© 1997-2002 J. Carlton Gallawa . All Rights Reserved Worldwide
You are visitor number 54668

Microtech

© 1998-2002 J. Carlton Gallawa
All Rights Reserved Worldwide

Last updated 1/2002

This page includes the brands:

Kenmore (Sears) to Montgomery Wards

Page 1

Instructions for Troubleshooting and Repairing Appliances

1. After reading the safety precautions, find the brand and model number, or the number closest to the model you are repairing.
2. Find the symptom(s) that most closely match the symptom(s) being displayed by the oven you are repairing.
3. Follow the specific troubleshooting and/or repair instructions to complete the repair. Click on highlighted text for a detailed explanation of that procedure.
4. Since this database is constantly being updated and appended, if you don't find what your looking for, try again at a later time.
5.

Click here

if you would like to be notified by e-mail when this page is updated.

Please Note:

- The manufacturers' part numbers and prices listed here are subject to change without notice.
- The individual model numbers are not necessarily arranged in numerical order

We hope that you find the information here helpful...

Important Safety Information

Repairing a microwave oven is a dangerous task. For your personal safety, please do not proceed unless you fully understand and are prepared to follow carefully these appropriate **safety precautions .**

Disclaimer: *The author assumes no liability for any incidental, consequential or other liability from the use of this information. All risks and damages, incidental or otherwise, arising from the use*

or misuse of the information contained herein are entirely the responsibility of the user. Although careful precaution has been taken in the preparation of this material, we assume no responsibility for omissions or errors.

© 1996-2002 J. Carlton Gallawa
All Rights Reserved Worldwide
© Copyright Information

Do good work.
Be careful.
Have success.

MICROWAVE OVEN REPAIR CASE HISTORY DATABASE (CONT'D)

KENMORE (Sears)

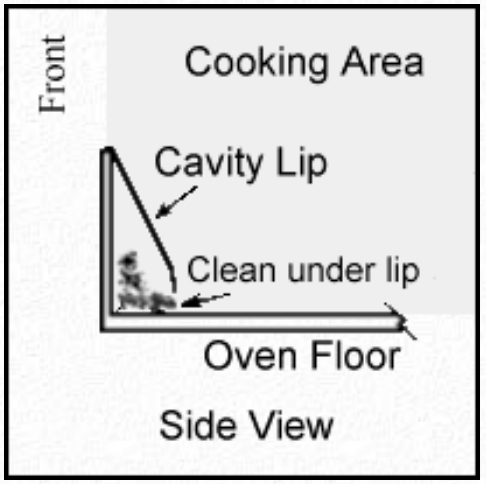
Model: 564.9998210
Symptom: Panel locked up.
Problem: Open capacitor C1 on printed circuit board Repair:Replace defective capacitor C1, 47MFD 100V

KENMORE (Sears)

Model: 564.9998210
Symptom: No heat
Problem: Open resistor in triac drive circuit caused by erratic operation of opto-coupler (PH1 or IC1)
Solution: Replace opto-coupler (or photo-coupler), part # 409-053-9501 and 220 ohm, 1 watt coupling resistor. Finally apply non-conductive sealer to pins of opto-coupler to prevent moisture, or roaming nocturnal visitor, from causing further erratic operation.

KENMORE (Sears)

Model: 401.8912980
Symptom: Arcing from inside the cooking compartment
Problem: Accumulation of food and cooking debris beneath front cavity lip.
Solution: Thoroughly clean all debris and carbon build up from under cavity lip (use a tool such as a plastic knife to penetrate underneath the lip opening and clear out all burned-on debris. Then use light sand paper to sand away any carbon build up. Finally, install a cavity lip protector, Amana part # R0803571. Price: about $8.00



KENMORE (Sears)

Model: 401.8934980
Symptom: Control panel intermittently locks up and will not program

Problem: Cracked solder joint at Crystal, XL1.
Solution: Repair cracked solder joint

KENMORE (Sears)

Model: 564.8598410
Symptom: None of the pads work except "fan" and "light"
Problem: Defective control panel and low voltage transformer
Solution: Replace control panel, part # 12359R. Price:$100.91. Also replace low voltage transformer, part # 12623. Price:$17.49

KENMORE (Sears)

Model: 564.8878420
Symptom: No heat and makes buzzing noise
Problem: Shorted high-voltage diode
Test: High Voltage Diode Test
Solution: Replace shorted diode. This diode is located inside of the high voltage capacitor. So, the entire capacitor w/diode assembly must be replaced. Price:$about $38.00

KENMORE (Sears)

Model: 564.9998010
Symptom: The control panel counts down, but nothing else happens
Problem: The plastic interlock switch actuator on the upper interlock switch has broken
Solution: Remove and disassemble the interlock switch assembly. Locate the small rectangular plastic lever that is used to actuate the interlock switch. Replace this latch lever, part # 11090. Price: about $1.00

KENMORE (Sears)

Model: 564.9998210
Symptom: The door must be slammed closed before the microwave will work
Problem: Defective upper door interlock switch
Test: Interlock Switch Test
Solution: Replace upper interlock switch assembly
Note: Generic interlock switches are available at appliance parts suppliers. Price, about $6.00. Be sure to match terminal arrangement, and current and voltage rating

KENMORE (Sears)

Model: 565.8904380
Symptom: Arcing and sparking in the bottom
Problem: Bits of food or other cooking debris have lodged beneath the coupling. After repeated exposure to microwave energy, the cooking residue breaks down into carbon (which is a conductor) and arcing occurs.
Solution: Clean out all residual grease and cooking debris. Remove all traces of the blackened residue (carbon) from the oven floor. Replace the coupling. Available at Sears for about $5.00

KENMORE (Sears) 566.8844780 DEAD WHEN WENT TO USE

Problem: Weakened fuse clips in the fuse receptacle causing fuse to melt due to resistive heat. Usually indicated by a bead of solder leaching out from either endcap , and/or evidence of overheating (or burned spot) at the endcap, fuse clip, or terminal connection
Solution: Replace 15 amp fuse (about $1.00) and receptacle (about $2.00)
Additional Inf: Generic fuse holders are available at appliance and electronic part suppliers

KENMORE (Sears)

Model: 721.18815181
Symptom: Oven went dead shortly after starting cook cycle
Problem: Weakened fuse clips in the fuse receptacle are causing the fuse to melt due to resistive heat. This is usually indicated by a bead of solder leaching out from either endcap , and/or evidence of overheating (burned spot) at the terminal connection
Solution: Replace 15 amp fuse (about $1.00) and receptacle (about $2.00).
Additional Info:Generic fuse holders are available at appliance and electronic part suppliers.

LITTON

Model: 1054.000
Symptom: Electrical burning smell during cook
Problem: Triac assembly is breaking down
Test: Triac Test
Solution: Replace triac. Part # M16D93. Price $35.00 and climbing

LITTON

Model: 1420.002
Symptom: Heard a noise then smelled electrical burning
Problem: Shorted high voltage rectifier
Test: High Voltage Diode Test
Solution: Replace shorted high voltage diode (rectifier). Generic replacement available at appliance parts suppliers for about $10.00 to $12.00

LITTON

Model: 1520.000
Symptom: No heat
Problem: Defective heat control module
Solution: Replace the heat control module. Part # M22D34. Possibly includes a dud value (e.g., part costs $115.00 + 25.00 [dud value]=$140.00. Defective [dud] part needs to be returned to redeem the $25.00)

LITTON

Model: 1580.000
Symptom: Works normally for awhile, then shuts off
Problem: Deteriorated connections at interface board
Solution: Clean the interface board edge connector and pins

LITTON

Model: 70-50.08
Symptom: Broken inner-door window
Problem: Stalled stirrer motor causing direct beams of energy to strike the inner door.
Repair: Replace stirrer motor, part # M12D5 and inner door glass, part # M51D1.
Additional info: On earlier models (before s/n *) stirrer blade should be upgraded to newer style, part # M44D13. Note:If stirrer motor is not defective, the upgraded stirrer blade may be all that is needed.

LITTON

Model: K-80/50.000, K-80/50.001
Symptom: When the door is opened, the oven powers up to the idle mode as normal (blowers, lamp, stirrer motor operating). However, when the door is closed, the oven will not stay in the idle mode as it should, rather it reverts back to the standby mode (nothing operating)
Problem: Although the problem would appear to be in the control panel, the failure is actually an opened secondary winding in the low-voltage transformer.
Test: Low Voltage Transformer Test
Solution: Replace low voltage transformer. Amana part # 45507P01. Price:about $30.00

LITTON

Model: 2052.000
Symptom: No heat
Problem: Auxiliary (power) Controller failing to provide primary voltage to the high voltage transformer.
Solution: Replace controller, part # M22D52 (probably subbed to new number). Price $80.00 $100.00 with $10.00 dud value.

To Page 2 (K to O)

A to J | K to 0 | P to Q | R to Z | Home Page | Safety Information | Back | CD-ROM | Links | FAQ |

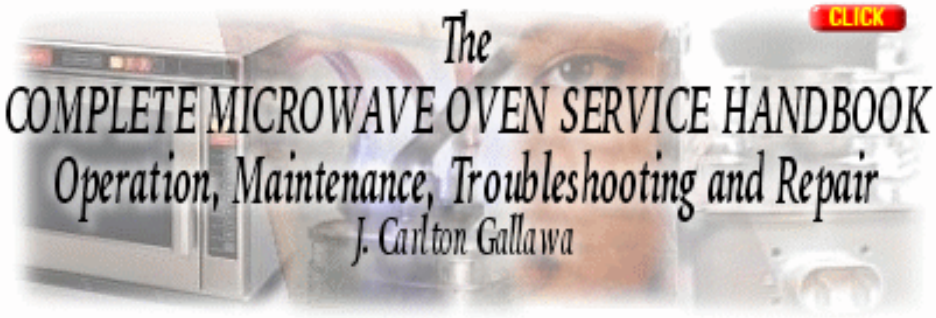
Parts Suppliers and Manufacturer Contacts

You can contact these parts suppliers and microwave oven equipment manufacturers directly for replacement parts, product literature, dealer locations, technical assistance, etc.
Please e-mail additions or corrections to: j.gallawa@cox.net

Glossary of Electronic and Microwave Oven Related Terms

Let us know what you think, or submit your own repair tip j.gallawa@cox.net

---



Stop and think about what you need to improve your electronics knowledge and job skills. Whether you are a do-it-yourselfer, a technical student, or a seasoned pro, enhancing your expertise makes you far more valuable. In fact, it could affect your entire level of professional success. Microtech's acclaimed "all-in-one" CD-ROM can help give you the edge you need!

©1998-2002 J. Carlton Gallawa . All Rights Reserved Worldwide

You are visitor number 39718 since 11/8/97

Microtech

© 1998-2002 J. Carlton Gallawa
All Rights Reserved Worldwide

Last updated 1/2002

This page includes case histories of the brands:

Panasonic to Quasar

Page 1

Instructions on How To Troubleshoot and Repair Microwave Ovens

1. After reading the safety precautions , find the brand and model number, or the number closest to the model you are repairing.
2. Find the symptom(s) that most closely match the symptom(s) being displayed by the oven you are repairing.
3. Follow the specific troubleshooting and/or repair instructions to complete the repair. Click on highlighted text for a detailed explanation of that procedure.
4. Since this database is constantly being updated and appended, if you don't find what your looking for, try again at a later time.
5.

Click here

if you would like to be notified by e-mail when this page is updated.

Please Note:

- The manufacturers' part numbers and prices listed here are subject to change without notice.
- **The individual model numbers are not necessarily arranged in numerical order**

We hope that you find the information here helpful. . .

Important Safety Information

Repairing a microwave oven is a dangerous task. For your personal safety, please do not proceed unless you fully understand and are prepared to follow carefully these appropriate safety precautions .

Disclaimer: ***The author assumes no liability for any incidental, consequential or other liability from the use of this information. All risks and damages, incidental or otherwise, arising from the use or misuse of the information contained herein are entirely the responsibility of the user. Although***

careful precaution has been taken in the preparation of this material, we assume no responsibility for omissions or errors.

© 1996-2002 J. Carlton Gallawa
All Rights Reserved Worldwide
© Copyright Information

MICROWAVE OVEN REPAIR CASE HISTORY DATABASE (CONT'D)

PANASONIC

Model: NE-7030
Symptom: Will not start unless door is pushed hard.
Problem: Burned connection at lower interlock switch.
Test: Interlock Switch Test
Solution: Replace switch and repair burned connections. Repair Info:Soldering the wires directly to the terminals provides the best connection, but installing new slip-on connectors is adequate.

PANASONIC

Model: NE-1057, NE-1057C, NE-1257, NE-1077, NE-1277, NE-1457, NE-1457C, NE-1757, NE-1477, NE-1777
Symptom: Code "F11" or "F12" appears on the display intermittently
Problem: Moisture is accumulating on control panel from steam rising out of the door.
Solution: Install foam sealer (cushion rubber) along lower edge of control panel escutcheon. Part # A8251-3180

PANASONIC

Model: NE-1457, NE-1757
Symptom: "F12" on display
Problem: Defective lower magnetron tube
Test: Magnetron Tube Test
Solution: Replace magnetron. Part # 2M210-M1. Price:$95.00

PANASONIC

Model: NE-1457
Symptom: Weak heat and low humming sound
Problem: Weak magnetron tube
Solution: Test each magnetron output independently to determine which magnetron is weak
Test: Output Wattage Test
Solution: Replace defective upper magnetron. Part # 2M210-M. Price:$95.00

PANASONIC

Model: NE-1757A
Symptom: Weak heat
Test: Output Wattage Test

Problem: Burned slip-on connector on magnetron filament-voltage input terminal
Solution: Repair burned connection as follows. Observe Important safety instructions . Either replace burned connector and clean up magnetron terminal; or, Remove burned connector, clean up terminal and solder wire directly to the terminal

PANASONIC

Model: NE-6850
Symptom: Sometimes the turntable doesn't turn.
Problem: Weakened turntable drive belt
Solution: Replace the belt. Part # ANE4110Q50GN. Price:$4.80

PANASONIC

Model: NE-8021, NE-8051, NN-4208A, NN-5407, NN-5500A, NN-5512A, NN-6370WM, NN-6371WM.N, NN-6372AWM, NN-6381A, NN-6482A, NN-6503A, NN-7524AK
Symptom: No heat, weak heat, or intermittent heat
Problem: Magnetron filament connectors have loosened and, due to resistive heat, the terminal connections have deteriorated and burned off.
Solution: Repair defective terminals as follows:Either (1) Cut away burned wire, clean the magnetron terminals, and replace the slip-on connectors, or (2) Cut away burned wire and connector(s). Clean terminals to prepare for soldering. Solder filament leads directly to magnetron terminals. Be careful not to apply soldering heat any longer than necessary

PANASONIC

Model: NE-200010P
Symptom: "PPPP" on display
Problem: Defective oven temperature sensor.
Solution: Replace temperature sensor, part # ANE604LK20AP, sub to ANE604LL20AP

To Page 2 (P to Q)

A to J | K to 0 | P to Q | R to Z | Home Page | Safety Information | Back | FREE Samples From CD-ROM

Parts Suppliers and Manufacturer Contacts

You can contact these parts suppliers and microwave oven equipment manufacturers directly for replacement parts, product literature, dealer locations, technical assistance, etc.
Please e-mail additions or corrections to: j.gallawa@cox.net

Glossary of Electronic and Microwave Oven Related Terms

Let us know what you think, or submit your own repair tip j.gallawa@cox.net

Finally, an instructional CD-ROM that actually instructs! Yes, practical education: Thorough without being vague, specific without being trivial. Here is a step-by-step guide to the electronic repair skills you need to profit from the challenging and lucrative repair industry. We invite you to take a look...

The COMPLETE MICROWAVE OVEN SERVICE HANDBOOK

Operation, Maintenance, Troubleshooting and Repair

Copyright © 1989-2002 by J. Carlton Gallawa

CLICK

© 1997-2002 J. Carlton Gallawa . All Rights Reserved Worldwide

You are visitor number 35790 since 11/8/97

Microtech

© 1998-2002 J. Carlton Gallawa
All Rights Reserved Worldwide
Last updated 1/2002

This page includes case histories of the brands:

Samsung to Whirlpool

Page 1

Instructions On How To Use This Information For Troubleshooting and Repairing Microwave Ovens

1. After reading the safety precautions , find the brand and model number, or the number closest to the model you are repairing.
2. Find the symptom(s) that most closely match the symptom(s) being displayed by the oven you are repairing.
3. Follow the specific troubleshooting and/or repair instructions to complete the repair. Click on highlighted text for a detailed explanation of that procedure.
4. Since this database is constantly being updated and appended, if you don't find what your looking for, try again at a later time.
5.

Click here

if you would like to be notified by e-mail when this page is updated.

Please Note:

- The manufacturers' part numbers and prices listed here are subject to change without notice.
- The individual model numbers are not necessarily arranged in numerical order

We hope that you find the information here helpful.. .

Important Safety Information

Repairing a microwave oven is a dangerous task. For your personal safety, please do not proceed unless you fully understand and are prepared to follow carefully these appropriate **safety precautions .**

Disclaimer: *The author assumes no liability for any incidental, consequential or other liability from the use of this information. All risks and damages, incidental or otherwise, arising from the use or misuse of the information contained herein are entirely the responsibility of the user. Although careful precaution has been taken in the preparation of this material, we assume no responsibility for omissions or errors.*

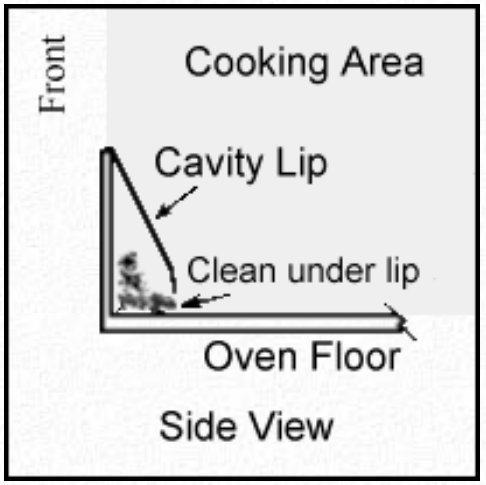
Do good work.
Be careful.
Have success.

© 1996-2002 J. Carlton Gallawa. All Rights Reserved Worldwide.
© Copyright Information

MICROWAVE OVEN REPAIR CASE HISTORY DATABASE (CONT'D)

SAMSUNG

Model: MV5510, MW 5690
Symptoms: First, arcing occurring while cooking. Now, now heat
Problems: (1) Accumulation of food and cooking debris beneath front cavity lip. (2) In addition, the magnetron filament connectors have loosened and, due to resistive heat, the terminal connections have deteriorated and burned off of the terminals
Solutions: (1) Thoroughly clean all debris and carbon build up from under cavity lip (use a tool such as a plastic knife to penetrate underneath the lip opening and clear out all burned-on debris. Then use light sand paper to sand away any carbon build up. Finally, install a cavity lip protector, Amana part # R0803571. Price: about $8.00 (2) Repair defective terminals as follows: Either (1) Cut away burned wire, clean the magnetron terminals, and replace the slip-on connectors, or (2) Cut away burned wire and connector(s). Clean terminals to prepare for soldering. Solder filament leads directly to magnetron terminals. Be careful not to apply soldering heat any longer than necessary



SAMSUNG

Model: MW5630T
Symptom: Timer counts down, but nothing else operates
Problem: Main relay on printed circuit board is not functioning.
Solution: Remove and disassemble Main Relay. Repair burned contacts.

SAMSUNG

Model: RE-525T

Symptom: Oven went dead between uses
Problem: Weakened fuse clips in the fuse receptacle causing fuse to melt due to resistive heat. Usually indicated by a bead of solder leaching out from either endcap and/or evidence of overheating (or burned spot) at the endcap, fuse clip, or terminal connection
Solution: Replace 15 amp fuse (about $1.00) and receptacle (about $2.00)
Additional Info: Generic fuses and fuse holders are available at appliance and electronic part suppliers.

SAMSUNG

Model: RE-705TC
Symptom: No heat
Problem: Faulty triac
Test: Triac Test
Solution: Replace triac. Universal triac replacements are generally available at appliance and electronic parts suppliers. Price: about $10.00

SANYO

Model: EM2500LA
Symptom: Lights and fan work, but there is no heat, and the smell of hot electrical insulation.
Problem: Shorted high-voltage transformer
Test: High-Voltage Transformer Test
Solution: Replace high-voltage transformer. Price: $90.00 to $120.00

SANYO

Model: EM-2501A
Problem: Shorted high voltage capacitor
Test: High-Voltage Capacitor Test
Solution: Replace the high-voltage capacitor and the line fuse. Universal replacements for both parts are available at appliance parts suppliers. The replacement capacitor should be within 10% of the original capacitor's microfarad (uF) value, and the voltage rating should be equal or higher.

SANYO

Model: EM-2520S, EM-3420A
Symptom: No heat
Problem: Defective triac has damaged the triac-drive circuit on the printed circuit board
Test: Triac Test
Solution: Replace triac (part # 12656, price: about $20.00); also replace the opto-coupler (also called photo-coupler), PH1 or IC1, part # 409-053-9501, and replace the 220 ohm 1 watt coupling resistor. Finally, apply non-conductive sealant, such as GE's RTV-102, to the pins of the opto-coupler to prevent moisture or roaming nocturnal visitor from causing erratic operation

SANYO

Model: EM703T
Symptom: Oven went dead half-way through a cooking cycle

Problem: Weakened fuse clips in the fuse receptacle causing fuse to melt due to resistive heat. Usually indicated by bead of solder leaching out from either endcap and/or evidence of overheating (or burned spot) at the endcap, fuse clip, or terminal connection
Solution: Replace 15 amp fuse (about $1.00) and receptacle (about $2.00)
Additional Info: Generic fuses and fuse holders are available at appliance and electronic part suppliers

To Page 2 (R to Z)

A to J | K to 0 | P to Q | R to Z | Home Page | Safety Information | Back | CD-ROM

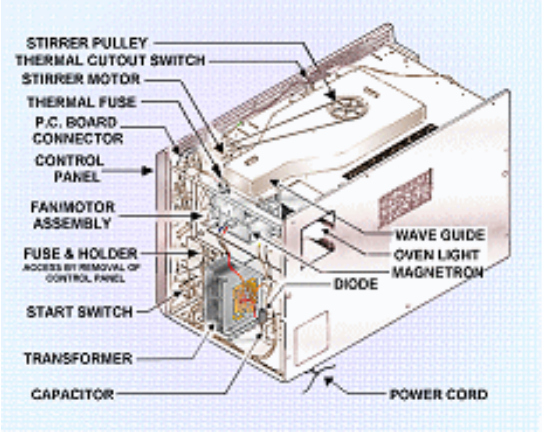
Parts Suppliers and Manufacturer Contacts

You can contact these parts suppliers and microwave oven equipment manufacturers directly for replacement parts, product literature, dealer locations, technical assistance, etc. Please e-mail additions or corrections to: j.gallawa@cox.net

Glossary of Electronic and Microwave Oven Related Terms

Let us know what you think, or submit your own repair tip j.gallawa@cox.net

Illustration from THE COMPLETE MICROWAVE OVEN SERVICE HANDOOK



If you would like to learn more about repairing commercial and residential microwave ovens and become part of a multi-million dollar service industry, we invite you to take a look at Microtech's powerful new computerized training course.

- **Virtually 1000s of microwave oven repair case histories with factory approved troubleshooting and repair procedures**
- **Factory troubleshooting charts, error codes, schematics and diagnostic procedures**
- **Touch panel (key pad) matrix diagrams for 100s of brands**
- **Hundreds of vividly colored schematics, diagrams, illustrations and photos ease the toughest repair chores.**
- **Fully searchable text for quick information gathering**
- **All chapters, sections and references are hyperlinked for fast and smooth navigating**
- **FREE technical support**

- **Full 30-day, no-questions- asked, money-back guarantee**

THE COMPLETE MICROWAVE OVEN SERVICE HANDBOOK 2000
Operation, Maintenance, Troubleshooting and Repair
J. Carlton Gallawa

© 1998-2002 by J. Carlton Gallawa . All Rights Reserved Worldwide